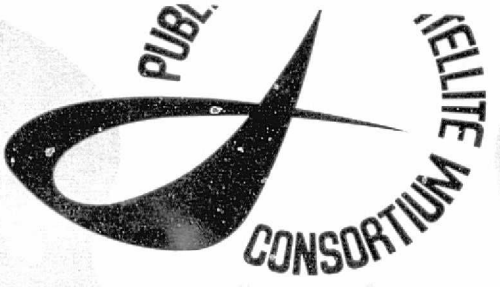
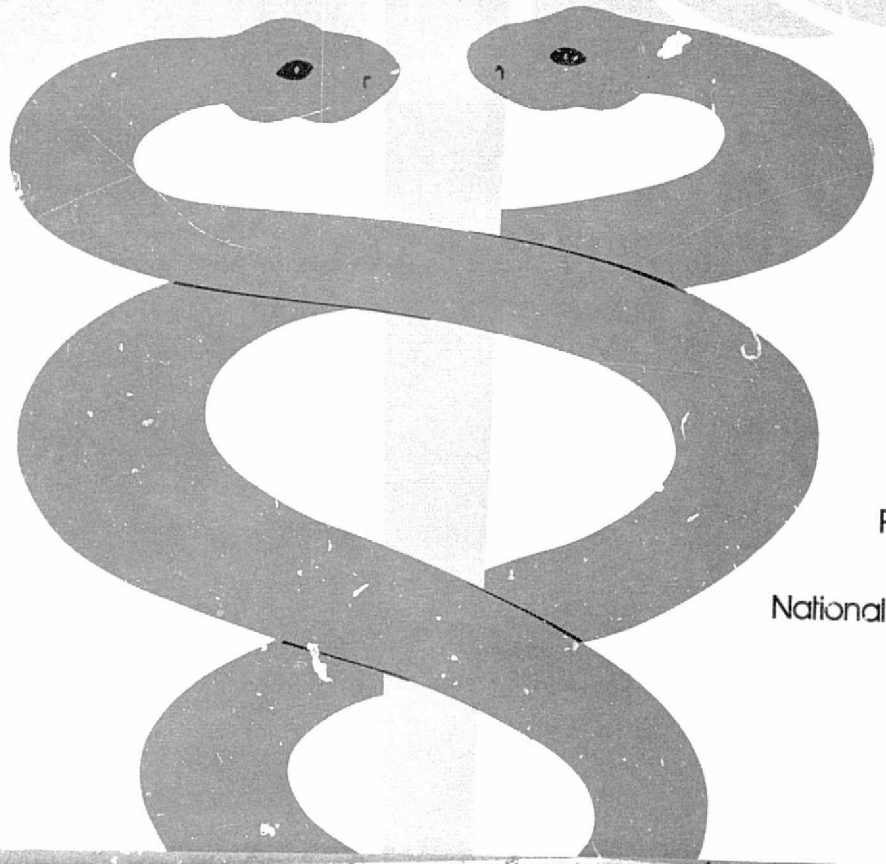
THE VALUE OF IMPROVED TELECOMMUNICATIONS SERVICE TO HOSPITALS

A Preliminary Assessment





by
PUBLIC SERVICE SATELLITE CONSORTIUM

prepared for
National Aeronautics and Space Administration
Goddard Space Flight Center
Contract NAS 5-23865
April 30, 1979

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THE VALUE OF IMPROVED TELECOMMUNICATIONS SERVICE TO HOSPITALS: A PRELIMINARY ASSESSMENT

by

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EXECUTIVE SUMMARY

This study is addressed to the value of improved telecommunications service to hospitals. In view of the rapid rate of development of domestic telecommunications services and the emphasis on private networks, PSSC sought to determine if hospitals had major requirements which could be aggregated and served by such networks. The value of the information transfer services judged to be most promising over the next 20 years is evaluated, based on expenditures and activity levels in five hospitals and one management services firm and the judgments of their senior staff. PSSC did not concern itself in this study with the present cost of providing these services or estimate when private suppliers will provide hospitals with the desired services at affordable prices. An implicit assumption is that essential services will become affordable once the hospital industry aggregates its requirements.

A methodology to evaluate the value of new telecommunications services in a hospital was developed and tested. A total of 92 senior staff in six institutions were interviewed by PSSC during this ten-month study.

Satellite Business Systems (SBS) supported PSSC in an advisory capacity. SBS has developed a methodology to determine external communications activity of large, geographically dispersed corporations that was modified to assess the peculiar needs of a hospital. The opinions expressed in this report are solely those of PSSC and do not necessarily represent those of SBS or NASA.

Most of the information which is vital to patient care today appears to be generated and processed within a local area about the hospital. Most individuals in the hospital industry are unaware of significant requirements for improved telecommunications service. The telephone, mail, and automobile appear to fulfill their present needs very well. Although there are definite external activity concentration points,

including doctors' offices, other hospitals, medical schools, vendors, and third-party payment agencies, most of the external information flow is now random and should be served by a public telecommunications network.

Improved telecommunications service probably will have little impact on the delivery of health care in the absence of substantial changes in the organization of hospital systems. Such changes, while painful and slow, nevertheless seem likely. The aggregation of this cottage industry by multiple-unit corporate systems is occurring at a rapid rate, and advanced communications should facilitate this process.

The most significant new applications of communications and data processing technology in hospitals during the 1980s probably will result from use of on-line data base technology. The experts consulted by PSSC during the survey strongly sensed that this technology could help hospitals solve many of their complex problems and would be well received by hospital administrators -- provided it was demonstrably cost effective. The eight applications felt to have greatest promise are: widely accessible, on-line data bases of patient records; remote diagnosis for specialist areas; point of origin data collection with input to central data bases; multiphasic health testing; video teleconferencing for administrative coordination; workload smoothing among multiple hospitals; educational support services; and assessment of the quality and utilization of health care services.

The creation of widely accessible data bases of patient records, financial data, resource-utilization data, and medical knowledge could produce important benefits. For example, preliminary information made available to PSSC suggests that the average length of stay of inpatients being treated by a hospital for the first time could be reduced by three days if the patient's medical record could be accessed by the hospital in a timely fashion.

Although it is difficult to foresee clearly the impact of continued development of communications and computer technology on the structure

of the health care industry, one thing is certain: the more modest the required institutional adjustments, the more likely is early acceptance. With this thought in mind, PSSC suggests eleven desirable network attributes, which are not entirely consistent with one another, as tentative design goals for the future development of health information networks: wide system connectivity; integrated functions; good security; reliability; flexibility; capable of modular growth; autonomous operation; integrity of data bases; uniform system standards; data bases easily shared; and productivity enhancing.

There are at least five barriers in the path of further development and eventual widespread implementation of medical information systems and health information networks: lack of consensus regarding a solution to the cost containment problem; lack of leadership from within the Federal health care establishment in support of a significant R&D commitment to medical information systems and health information networks; lack of standards; inadequate safeguards to insure privacy of sensitive data bases in a distributed hospital environment; and lack of capital within the health care industry to invest in communications and data processing systems, particularly at rural and inner city institutions which most need improved access to health care services.

On the other hand, the general trend today toward consolidation of institutional providers should facilitate implementation of medical information systems. Should the federal government elect to utilize prospective reimbursement formulas for Medicare patients and to become more aggressive in setting standards, it could create further incentives for health care providers to consolidate services and place a higher premium on effective management, planning, and resource allocation.

PSSC recommends that the health care industry consider formation of communications cooperatives to oversee development of medical information systems and health information networks. Should the industry be unwilling or unable to place responsibility in a small number of management agents,

the latent capabilities of this technology to support higher level planning and control functions may remain dormant indefinitely.

The findings and recommendations of this report are based on detailed study of five hospitals and one management services firm out of a U.S. population of 7,099 hospitals. Thus, they are merely indications of an underlying reality that should be validated by a survey of a larger cross section of the health care industry.

Dr. James G. Potter, PSSC's director of planning and analysis, was Principal Investigator of this project. He was assisted during the field surveys by Ms. Polly Rash, PSSC's director of communications. Dr. Thomas E. Terrill of Akron City Hospital and Mr. James H. Brown and Mr. Jack D. Schiff of Satellite Business Systems provided conceptual assistance throughout the study.

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INTRODUCTION

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Improved telecommunications service is not a panacea for the extremely complex problems now faced by the health care industry. Most critics of the industry agree, however, that its continued growth and improvement will come about through the reorganization of disparate, autonomous institutional providers. Improved telecommunications service could facilitate this process.

The last 25 years have witnessed a phenomenal growth in health expenditures; the percentage of the gross national product which is committed to the purchase of health care has doubled since 1953.[1]

CHAPTER I

Productivity gains in the health industry have not been commensurate with its staggering rate of inflation. Whereas the consumer price index has increased by 152% since 1950, hospital costs have increased by 836%.[2] The current emphasis on clinical technology has not increased productivity; on the contrary, the number of hospital personnel per patient has risen from 2.26 to 3.16 since 1960.[3] Physician productivity, as measured by patient visits, has remained constant for 20 years.[4,5] The quality of medical care also has improved enormously, but there is growing recognition that improved quality of care is not in itself adequate justification for a proposed capital investment in a hospital. The average citizen is becoming increasingly concerned with productivity problems in the health care industry. He wants the best possible care for his loved ones and cost effective care for most others. Not surprisingly, consensus regarding a blueprint for reform of the health care industry has not emerged.

The recent explosion in medical technology has increased public expectations of our health institutions and has brought pressure upon physicians and administrators to keep pace with the latest technological developments. This new technology is expensive. Smaller institutions cannot afford the expensive apparatus that modern medicine requires. These institutions are being compelled to share facilities or to merge in some fashion with other institutions or to focus on patients whose treatment does not require expensive hardware or specialized personnel. Twenty-three percent of the nation's acute-care beds are now associated with multiple-unit hospital systems, a figure that is expected to rise to 35% by 1980 and to 65% by 1990.[6] Public Law 93-641, which was passed by the U.S. Congress in 1974, contains explicit incentives to form multiple-unit health service systems.[7]

The improvement in domestic telecommunications service in the 1980s should reinforce this trend toward consolidation of health care systems. Competition involving firms such as AT&T, Exxon, Xerox, and IBM to

provide specialized network services and thereby improve office productivity will impact throughout the U.S. economy. The advent of wideband information networks, such as those under development by AT&T, Western Union, Xerox, and Satellite Business Systems, could dramatically strengthen linkages between institutional providers by making it possible to provide a range of clinical, educational, and administrative support services to any other provider in the network. These institutional linkages could be established without regard to present time or distance constraints. Indeed, electronic delivery of health care services could open up a world market to U.S. providers.

The feasibility of using advanced communications to improve access to health services, create new markets, and stimulate competition in the provision of specialized support services has been demonstrated beyond reasonable doubt.[8-11] Communication networks could facilitate formation of hierarchical health delivery systems in which the patient is treated at the lowest possible level of a pyramid structure consisting of primary care, secondary care, and tertiary care centers. Whether advanced communications can help the hospital industry curtail its present high rate of inflation, however, is unclear.

The findings and recommendations of this report are based on a detailed study of five hospitals and one for-profit management services firm out of a U.S. population of 7,099 hospitals. Thus, they are merely indications of an underlying reality that should be validated by a survey of a larger cross section of the health care industry.

B. Objectives of Study

One objective of this study was to determine total external communications related activity in terms of present expenditure levels and traffic detail in four representative U.S. hospitals. Included in this assessment was a quantitative description of cost savings likely to result from reduced communications constraints for existing operations and a qualitative description of value-added benefits likely to result from new applications of communications systems on future operations.

Figure 1
OBJECTIVES OF STUDY

- Determine total external communications related activity in four representative U.S. hospitals.
  1. Present Operations (Quantitative Results)
     A. Expenditures for voice, data, mail/fax, meetings, televisual services
     B. Determine external internodal traffic to "major" nodes (function, destination, performance, volume, frequency)
  2. Future Operations (Qualitative Results -- or at least subjective)
     A. Assess benefits on present operations (less cost, better performance, added growth)
     B. Identify new applications; describe value
- Develop and test micro-study approaches.
- An initial survey of communications needs of hospital industry, not a definitive study.

PSSC developed a list of possible applications of advanced communications in hospitals, based on review of the literature and interviews with experts. The value of these applications was assessed by interviewing senior level hospital staff. PSSC was particularly interested in the attitudes of hospital professionals toward sharing or procurement of vital services from outside suppliers.

A second objective of this study was to develop and test a methodology to evaluate demand for advanced network services in a typical hospital, recognizing that this initial sample of four hospitals is but a first step in determining the requirements of the U.S. health care industry.

C. Study Procedure

In an earlier study for NASA, PSSC examined four sectors of the public service to determine if aggregation of a broad base of users in support of new telecommunications services was feasible.[12] PSSC concluded

that there are system-wide needs in the hospital industry that could be addressed with advanced communications, and NASA agreed to fund this present study to evaluate requirements in greater detail.

Satellite Business Systems (SBS) agreed to support PSSC on this study in an advisory capacity. SBS is interested in public service applications of its system and assisted PSSC in the development of a methodology to determine the external communications activity of a typical hospital and the value of removing existing communications constraints. The opinions expressed in this report are solely those of PSSC and do not necessarily represent those of SBS or NASA.

The survey methodology was validated at a large, independent hospital. PSSC then surveyed four hospitals of a single multiple-unit system. Additionally, personnel of a contract management firm which serves this system were interviewed. In all, a total of 92 separate, 90-minute interviews were conducted over a seven-month period. Two half-day "discovery sessions," which involved some of the more creative participants in the study, were conducted at the end of the survey.

It was not clear a priori to what extent hospitals could benefit from participation in a private network. The most important and frequent forms of information exchange which affect patient care tend to occur within the confines of the institution. Such activity was not germane to this study; attention was focused on traffic in voice, data, facsimile, video, mail, or meetings which involved parties external to the institution. Of particular interest was the existence, or lack thereof, of external activity concentration points.

D. Outline of Report

A tutorial discussion of the communications environment that is anticipated in the 1980s appears in Chapter II. At this same time some general trends in the U.S. hospital system are reviewed, with specific emphasis on the utilization of computer technology in hospitals. Much

of this material was presented to the individuals who were interviewed by PSSC to guide their thinking regarding the value of improving the present communications environment and thus is a part of the methodology used by PSSC to obtain its findings.

The methodology used to determine present communications activity and to assess the value of improved communications on future operations is described in Chapter III. A summary of the present external communications environment of the five hospitals surveyed is presented in Chapter IV, and the eight applications of an advanced communications system that are considered to be especially promising are described in Chapter V.

The reader who is familiar with applications of data processing in hospitals will not be surprised by the discussion of promising applications. The creation and widespread use of shared data bases could have considerable impact on the practice of medicine. While it is difficult to foresee the impact of continued development of communications and computer technology on the structure of the hospital industry, one thing is certain: the more modest the required institutional adjustments, the more likely is early acceptance. A discussion of desirable attributes for a health information network appears in Chapter VI.

At the present time, there is little evidence of large activity concentration points external to the average U.S. hospital. Thus, improved telecommunications probably will have little impact on the delivery of health care in the absence of substantial changes in the organization of hospital systems. Such changes, while painful and slow, nevertheless seem likely. The aggregation of this cottage industry by multiple-unit corporate systems is occurring at a rapid rate, and advanced communications should facilitate this process.

A discussion of barriers to implementation and recommendations for further development appear in Chapter VII.

CHAPTER II

BACKGROUND

A. Trends in the U.S. Communications Environment*

Major shifts in the deployment of the U.S. labor force have occurred since the turn of the century. Approximately 50% of the labor force was engaged in agricultural activities in 1900 versus about 5% today. During this same period the portion of the labor force engaged in providing information services has risen from approximately 10% to 46%, while the fraction of the labor force engaged in the production and distribution of goods has remained fairly constant.**

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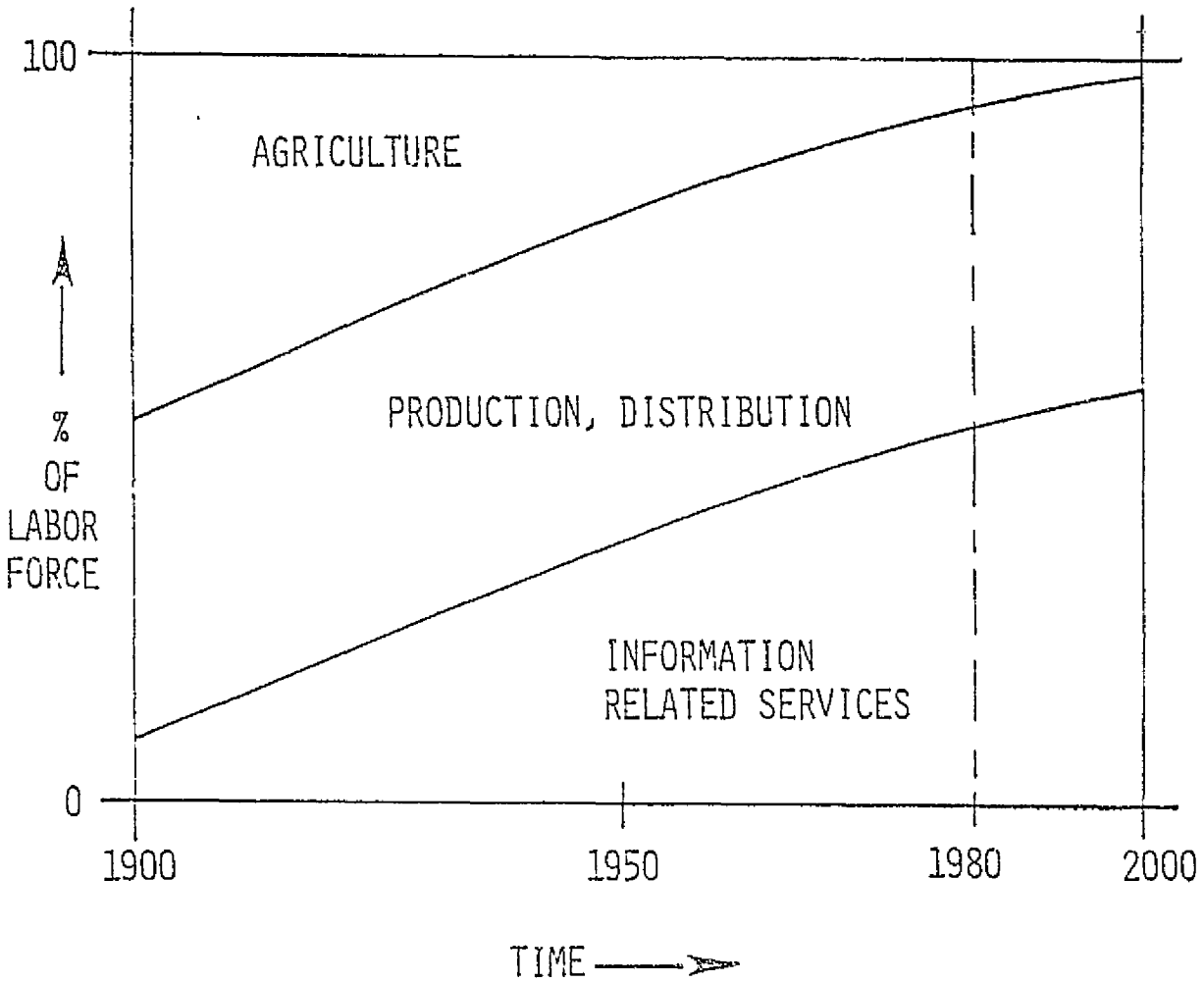
* The material of this section is based on unpublished viewgraphs which were conceived by James H. Brown and Jack D. Schiff of Satellite Business Systems, McLean Virginia.

** By definition, all employees of organizations which are engaged primarily in the origination, processing, or dissemination of information fall into the category of "information related services." Thus, employees in such industries as data processing, telecommunications, publishing, broadcasting, and education are included. Additionally, all employees who work in the bureaucracy of either the public or private sector are included. This group includes all those people who are not directly engaged in the production of goods. The basis for these figures is contained in a publication of the Department of Commerce entitled The Information Economy: Definition and Measurement.[13]

Figure 2. Employment Trends in U.S. Labor Force



It is apparent that the productivity of persons who are engaged in information related services is having an increasingly direct bearing on the productivity of the U.S. economy as a whole. Yet, until recently, there has been little R&D investment directed toward improving the productivity of such functions.

Private industry, however, now senses the opportunities which investments in office technology R&D may provide, and a large portion of the current development activity in communications and computer technology appears to be focused on the automated office.[14] New initiatives now under development by such companies as AT&T, IBM, Xerox, and Exxon will have a large impact on most segments of the U.S. economy in the 1980s.[15]

The trends in telecommunications since the turn of the century are depicted in Figure 3. By 1900 the telephone already was overtaking the telegraph as the principal means of electronic information transfer. Today the telephone is by far the most widely utilized telecommunications modality in the U.S., accounting for approximately 80% of total revenues in the industry. The importance of video and data communications is growing, however, and they are expected to account for an increasing percentage of telecommunications revenues through the remainder of the century.

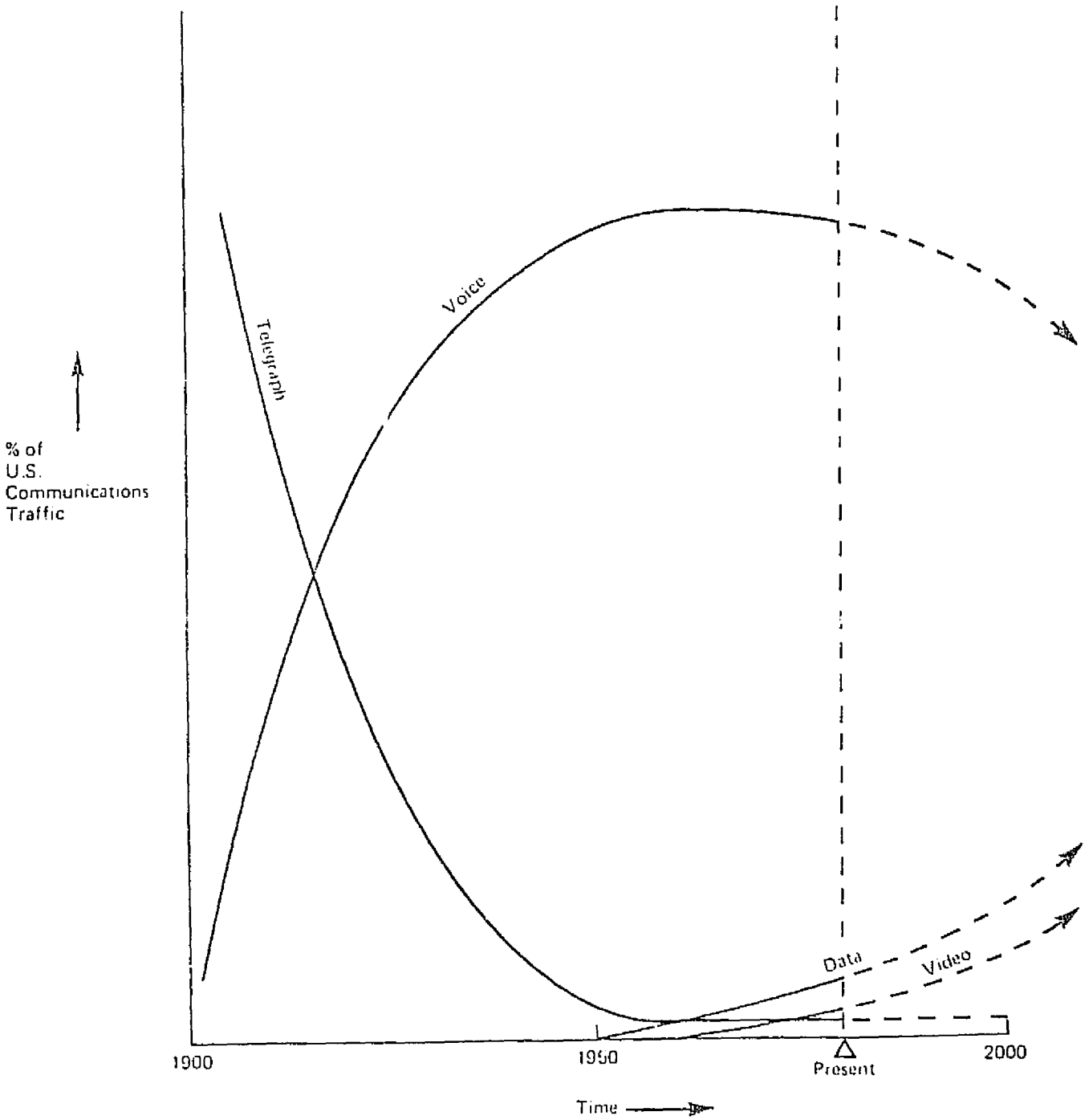
To gain a visceral sense of the significance of these trends in information transfer, consider the service improvements in the basic delivery modes since 1900. At the turn of the century one could comfortably take a 100-mile business trip in one day and return home that evening. Letters could be delivered in two to seven days; one could send a 100-word telegram in hours; and there was local telephone service.

By 1935 the automobile had made it possible to take a 200-mile business trip in one day; letters generally reached their destination in one to seven days; the telegraph was declining in use; radio broadcasting was approaching maturity; and there was a nationwide telephone network. National telephone service, in fact, was a major factor in allowing expansionist businesses to operate successfully on a nationwide basis.

FIGURE 3

TELECOMMUNICATIONS TRENDS

1900 - 2000



Source: NASA Contract = NSA-5369, 1970

Not to Scale

CHAPTER II

By 1970, the jet airplane had made it possible for one to comfortably undertake a 1,000-mile business trip and return the same day. Mail delivery was still averaging one to seven days, and the public telephone network was supporting multiple uses, such as data communications and facsimile. Video broadcasting had become a large industry, and private communications networks, which had been quietly growing since the late 1950s, now were attracting widespread attention due to the interest of many parties in the possibilities of satellite communications.

The basic limits in travel, mail, telegraph, and telephone service are expected to remain unchanged through the mid 1980s. Competition in the provision of telecommunications, which is centered in the area of private networks, is becoming increasingly intense. The consumer will have many more service options.

Voice communications will remain the most important means of electronic information exchange in the 1980s, but in addition there will be a number of new services in the areas of video teleconferencing, electronic mail, imaging and sensing, data processing, and "office of the future" services. These services will be available both from the public networks that are operated primarily by AT&T and GTE (the Advanced Communications Service and the Picturephone Meeting Service being two ambitious new developments) and from private networks that will be operated primarily by AT&T, GTE, and a number of specialized carriers. There is likely to be intense competition among the common carriers and specialized carriers in developing markets for new service offerings.

Video teleconferencing will be used as a substitute for travel to conduct many business meetings. Certain types of meetings, such as personnel evaluations, meetings between relative strangers, or meetings where emotional factors may play an important role in the decision making process, probably will continue to be conducted in the conventional manner. For most other types of business meetings, video teleconferencing is

likely to be regarded as an acceptable modality by a majority of people, once they become accustomed to the adjustments in meeting formats which will be required.[16] The teleconferencing facilities that will become available in the 1980s will offer flexible communications arrangements which the user can tailor for one-to-one meetings, seminars or presentations which require a one-to-many format, and meetings involving many participants who interact from many locations. Experiments have shown that acceptable results can be obtained using video quality levels considerably below that required for broadcast television.[17] High resolution video will be available as needed to transmit engineering drawings or medical information, however.

Electronic mail is not new; Western Union has been offering variations of this service for many years. A company which purchases a private communications network will be making increasing use of electronic mail during off-peak hours. Initially, this use of electronic mail service probably will be provided from mail room to mail room using high-speed telecopiers which will be capable of transmitting print quality documents at speeds of 30 pages a minute.

The "office of the future" or "paperless office" eventually will lead to the replacement of many file cabinets with distant and local data bases, which will be widely accessible via high-speed communications circuits. The key to acceptance of this concept is pervasive use of intelligent, low-cost data entry equipment with volume local storage. Word processing equipment is now relatively expensive, and "desk top to desk top" information transfer is likely to remain the exclusive domain of the telephone until the latter part of the 1980s.

The 1980s will see more widespread diffusion of data processing applications. The availability of low-cost high-speed communications will permit load sharing between computer systems, a technique which is now used when two computers occupy the same room but is impractical when

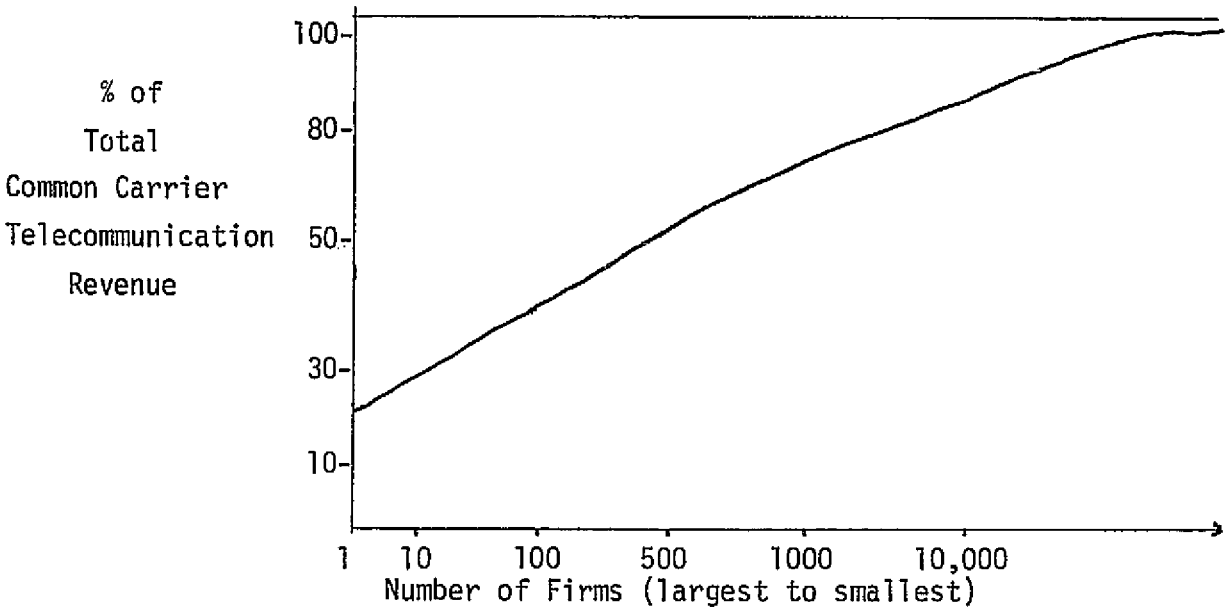
they are in different cities. It will also be possible to gain more rapid access to data bases and to transfer large files. Because the cost of minicomputers is declining dramatically, many users will make extensive use of both dedicated computers and time-shared machines. High-speed communications will make it possible for mini and microcomputers to access distant data bases and sources of specialized software.

Digital image enhancement techniques, which have been developed by NASA and the intelligence community, will be used increasingly in medicine. High speed communications will permit centers of expertise in noninvasive testing to provide real-time clinical support to other institutional providers. The development of appropriate sensors will increase the effectiveness of remote service bureaus in cardiology, pathology, pulmonary medicine, radiology, and neurology.

What is the significance of all this? Almost certainly improvements in the communications environment coupled with the energy crisis will result in increasing dependence on communications to perform functions that now involve travel. Constraints imposed by time and distance will become less significant as businesses reorganize to take advantage of the capabilities of advanced communications. Industries increasingly will share data, experts, and facilities and eliminate unnecessary duplication. MacKenzie predicts that advanced communications networks will allow especially well managed organizations to gain the benefits of centralized control and decentralized operations.[18]

Which industries will benefit first from the expected improvements in communications services? In the absence of government incentives, those where the demand for private-line communications will be highest. Figure 4 is a histogram displaying the cumulative telecommunications revenue contributed by the largest corporate entities in the U.S., including the Federal establishment. The 500 largest firms in the U.S. account for more than 50% of total telecommunications revenues. The Federal government by itself accounts for over 20% of total revenues. Each of these firms is a leading candidate for improved service. Hospital systems are unlikely to be served until their requirements can be aggregated.[19]

Figure 4. Cumulative Distribution of Telecommunications Expenditures in the U.S.



B. Trends in U.S. Hospital System

Several milestones in the development of the hospital industry are displayed schematically in Figure 5. By 1910 use of anesthetics and antiseptic techniques had gained widespread acceptance, completely changing the complexion of hospitals. Prior to this time hospitals tended to be hospices for the chronically ill where the poor went to die. The use of antiseptic techniques made hospitals places where the sick were cured, and they began to attract support from the middle class. There was a perceptible surge of medical knowledge immediately following World Wars I and II because of the enormous volume and range of problems which required immediate attention. The Hill-Burton Bill was approved by Congress in 1946, releasing a total of $4,460 million of hospital construction grants and $1,468 million of loans which have supported over 7,700 projects through March 1979.[20]

CHAPTER II

World War II persuaded Congress that there was value in supporting basic research. The total federal investment for health research exceeded $33 billion from World War II through 1978. This infusion of investment dollars has revolutionized the practice of medicine, and physicians have eagerly sought to have hospitals install sophisticated equipment to keep them at the forefront of medical practice. Examples include instruments which make it possible to perform surgery under a microscope, pacemakers and open heart surgery which have reduced mortality from heart disease, organ transplants and kidney dialysis, and diagnostic techniques such as computer-assisted axial tomography (CT scanners) and automated EKG machines. All too often, however, these investments in technology have increased the price of medical care. While the patient always wants the highest quality medical care, which the physician instinctively wants to provide, the health care industry is now being forced to ask: "What standard of quality is good enough?"

Since 1960, total national expenditures for health services have risen more than eight times, from $20.9 billion to $162 billion. During this same period there has been a dramatic shift in the role of the federal government in the financing of health services: the federal contribution has increased from 25% to 40% of total expenditures. This shift from private to public funds is due primarily to the introduction of Medicare and Medicaid in 1966. A breakdown of the cost elements of the health care industry and its sources of revenues appears in Figure 6.

Increasingly sophisticated medical technology requires that more and more care be provided where elaborate equipment is available. The fact that the population is growing older has increased the demand for both hospital beds and nursing homes. The hospital and nursing home are becoming the key elements of the U.S. health care system and the government is becoming its principal financier.

It is also apparent from Figure 5 that the percentage of total expenditures allocated by hospitals for personnel has been declining

steadily since 1960 -- even though the number of personnel per patient has risen since 1960. Hospitals have not been reluctant to invest in technology, nor is their faith in technology diminishing. The emphasis is shifting, however, from quality-enhancing technology to productivity-enhancing technology. This trend began in the mid 1970s but is not expected to be broadly felt by the hospital industry until the mid 1980s. The percentage of hospital expenditures on personnel and the number of personnel per patient are expected to enter a period of steady decline during the first half of the next decade.

The principal support for hospitals tends to come from the local communities they serve, and hospitals have become very adaptable to the changing needs of the local community. With their strong local political support, hospitals also tend to be highly impervious to policy direction from the federal government. The strong preference of this industry for independence and local autonomy has led to the development of a cottage industry. Of the 7,099 hospitals in the U.S., 47% have less than 100 beds.

The cost containment era began in 1971 with the introduction of the Economic Stablization Program of the Nixon administration. Cost containment continues to be the top priority of the hospital industry, and is probably the main reason for the trend toward consolidation of health care institutions.[6, 21-24] Multi-unit hospital systems apparently are more efficient than autonomous hospitals, and third party payment agencies and private companies having group insurance programs are placing increasing pressure on hospitals to consolidate. According to Jack McMehan, Executive Director, Philadelphia Health Management Corporation: *"Institutions that start structuring themselves with other institutions now will be the ones to survive in the future. Those who don't aggregate won't last."*[25]

Figure 5. Trends in Hospital Expenditures

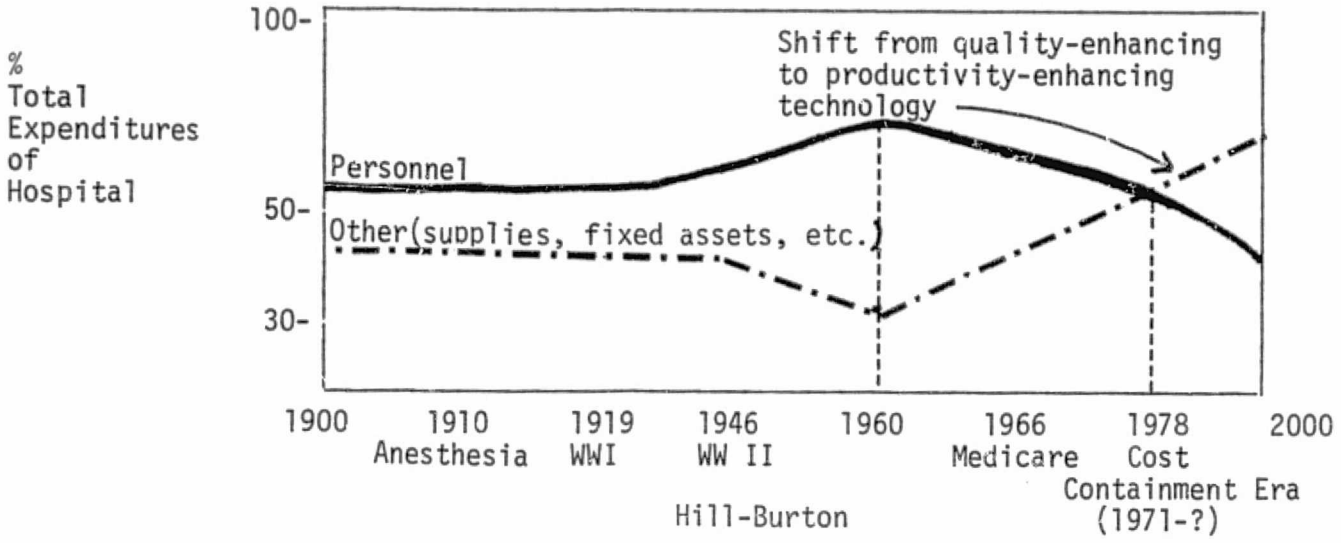
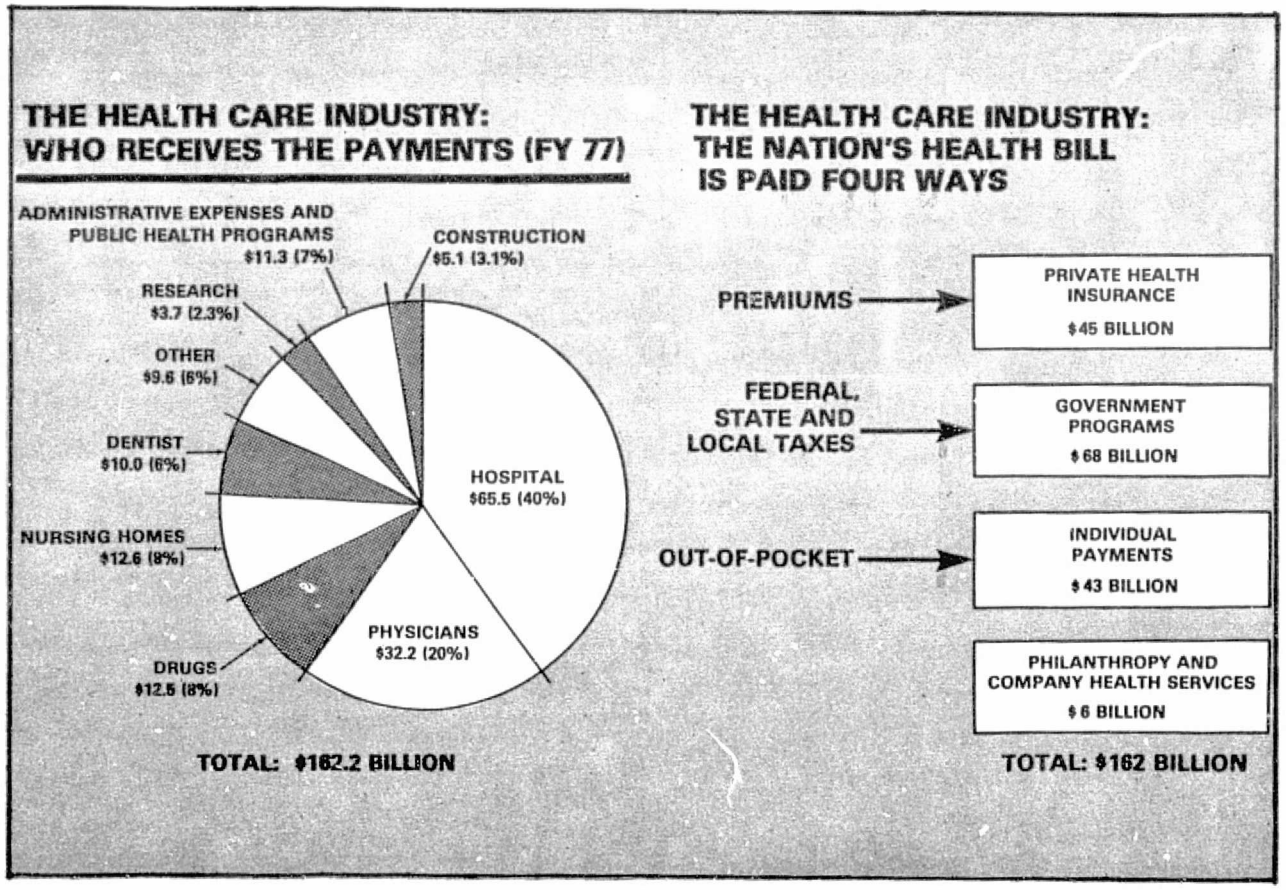


Figure 6. Breakdown of Health Care Expenses and Revenues (Taken from Forum on Medicine, American College of Physicians, September 1978)



C. Trends in Hospital Data Processing Environment

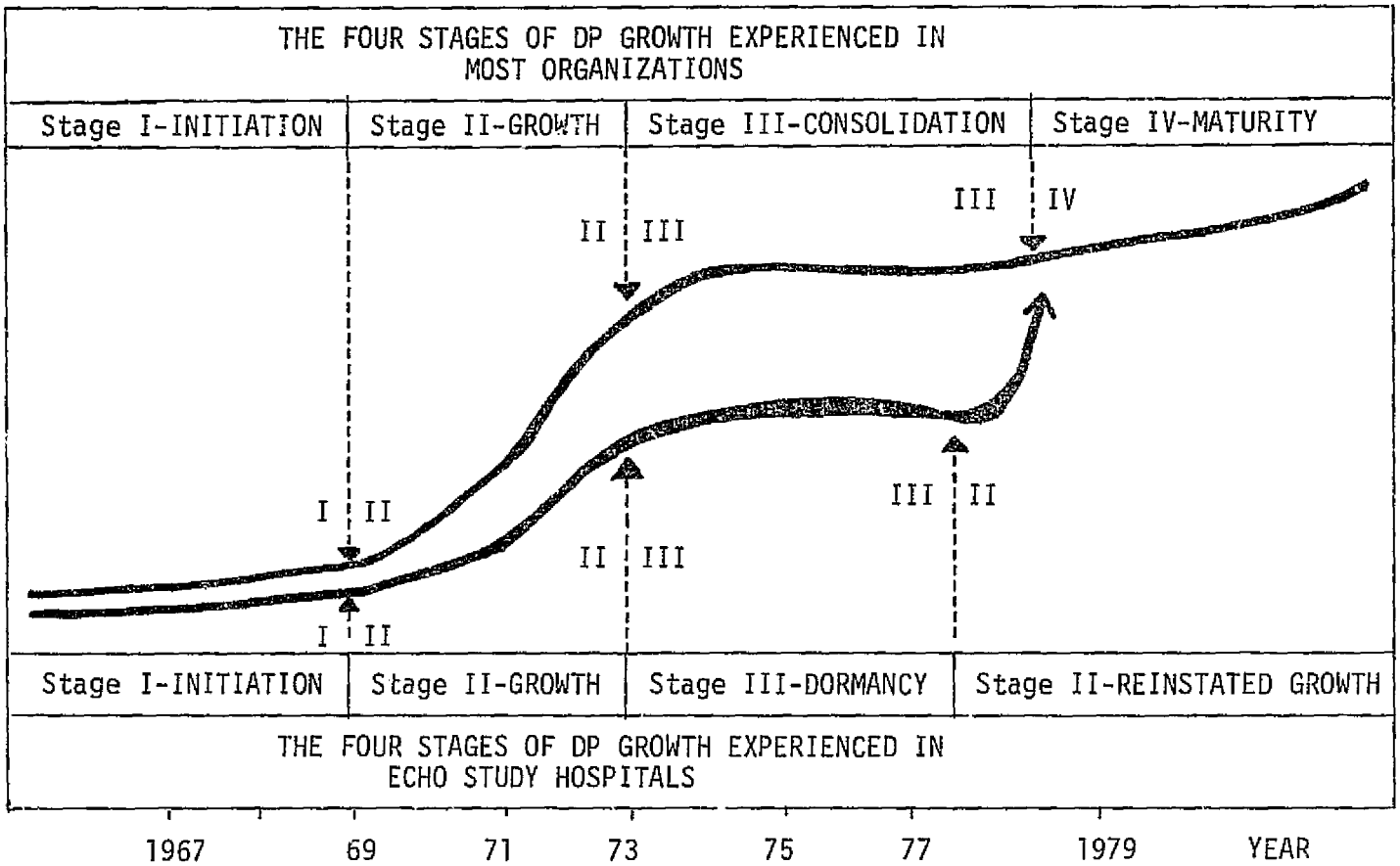
The digital computer is perhaps the most significant management tool which has been developed in the 20th century. How has the hospital industry been using this tool in recent years? With mixed results.

A study of the pattern of utilization of data processing in the health care industry was commissioned by IBM, the Electronic Computing Health Oriented organization (ECHO), and participating hospitals in 1976. Richard L. Nolan, David P. Norton, and William E. Bowen of the D.P. Management Corporation who performed the study concluded:[26]

> *"Historical use of the computer in hospitals has been dedicated almost exclusively to low-level financial (accounting) applications. Only limited opportunities exist to gain further payoff in this area.*
>
> *Little use of the computer has been made in supporting higher level financial management activities associated with planning and control. Prospective rate setting and other similar external forces will find hospital administrative systems ill-prepared to adapt.*
>
> *Major opportunities to control cost and improve patient care exist outside of the financial function in hospitals. Because of the unique requirements for information transfer which prevail in medium and large hospitals, these benefits are contingent on the use of on-line computer technology."*

The authors compared the evolution of data processing technology in hospitals with other industries. Their conclusions are displayed graphically in Figure 7. Data processing (D.P.) expenditures in most organizations go through four distinct stages of growth. In Stage I, a computer is installed to perform specific, easily automated functions such as payroll, accounts payable, and accounts receivable. Although the initial expense is high, the operating costs for these narrow operations is usually low, and there is little need for management to closely monitor performance.

Figure 7. Comparative Evolution of Data Processing in Hospitals and Other Organizations [27]



Success of the first applications usually encourages other departments to develop new data processing applications, resulting in rapid growth of the D.P. budget (Stage II). But with inexperienced D.P. personnel (often recruited from user departments) and no formal planning process to map out short and longer range strategies, benefits of the new services provided are not commensurate with the costs.

The high costs of Stage II and the problems associated with uncontrolled growth lead management to institute strict controls in Stage III. The D.P. department is often placed under the Vice President of Finance, who represents the largest user and tends to be critical of proposals

which don't offer early cost recovery. Growth and D.P. initiative slow to a crawl.

In Stage IV new applications again are pursued, but there are now appropriate management controls to insure that systems are effective for the user and the computer. D.P. growth in Stage IV is steady and managed.

Nolan, Norton, and Bowen, in a summary of the ECHO report for publication, observed:[28]

> *"In hospitals, the growth of data processing has differed from this general pattern. Stage I was the same; but the rapid increase in applictions typical of Stage II was prematurely curtailed because of insufficient funds, lack of user pressure for new applications, and inadequate technology and skills to develop more sophisticated applications. As a result, hospitals did not expand their use of the computer much beyond the accounting applications normally developed in Stage I."*

Many hospitals are now reentering Stage II of the D.P. evolutionary cycle, and their leadership faces the difficult task of rekindling optimism that computer applications which failed previously will be successful the second time around.

It is not altogether clear why hospitals have been relatively unsuccessful in their previous attempts to expand data processing applications. Nolan, Norton, and Bowen attribute their difficulties to three factors. First, hospitals were under pressure during the 1971-73 Economic Stablization Program to contain costs. At a time when more funds were needed to achieve D.P. success, funds were withdrawn, hastening its failure. Second, the level of investment in hospitals in new D.P. systems development is unusually low:

> *"An average 10% increase in D.P. budgets, devoted entirely to staff new systems development, would increase the average hospital's ability to design or install new information systems by 200%."*[29]

Third, hospital senior management have not taken a sufficiently active role in the planning and control of D.P. activities.

The indications from PSSC's survey reinforce this last observation. Until recently, most senior-level hospital administrative personnel have had their professional roots in medical science or public health, rather than in business administration. They have tended to be particularly sensitive to investment alternatives that are likely to have direct impact on patient care, such as a new CT scanner or a SMACK[8] machine, and less enthusiastic about suggested changes aimed at improving administrative efficiency, such as a medical information system. The medical staff typically reinforces this tendency. In fact, the organizational structure of many hospitals resembles a series of semi-autonomous fiefdoms. When investments in data processing technology are made by the hospital administrator, his path of least resistance is likely to be in the direction of support for modular data processing systems that benefit individual departments rather than toward a comprehensive medical information system that could benefit the entire hospital -- but is likely to be disruptive of established working routines. In view of these political factors, suppliers of medical information systems understandably have focused on departmental systems rather than on integrated systems.

While commercially available medical information systems appear to be cost effective, the evidence is not yet compelling. According to a November, 1977 report of the Office of Technology Assessment entitled "Policy Implications of Medical Information Systems:"[30]

> *"Medical information systems cost about double the current average expenditure for the financial and management computer applications that they replace. Hospitals attribute savings in other areas to medical information systems: the elimination of printed forms, reductions in clerical, admissions, and nursing staff, and reductions in 'lost charges.'*[31] *Because medical information systems could make possible improved cost accounting, reductions in length of patient stay, and increased productivity of medical care professionals, other savings may accrue. El Camino Hospital (estimated that) net benefits (from its Technicon medical*

information system), after paying for the costs of the system, ranged between $3 and $5 per patient day. Labor savings, particularly in nursing, accounted for about 95% of the estimated cost savings."[32]

Economic benefits based on projected reductions in the labor force can be ephemeral in public service institutions, and the rate of adoption by hospitals of medical information systems has been low despite the fact that a detailed case for cost effectiveness was established by El Camino Hospital in 1975. Only ten hospitals have purchased Technicon's system since the sale to El Camino Hospital over seven years ago.[33]

Another factor that is not mentioned in the ECHO study is that many non-financial activities in a hospital are inherently difficult to automate. The pattern of information flow in a hospital is exceedingly complex. There appears to be a need for further research into the fundamental requirements for information transfer in a hospital, particularly in the clinical areas. It is not clear, for example, to what extent computer technology should be used in medical diagnosis or in patient monitoring. In a February, 1979 panel discussion at Compcon, a symposium sponsored by the Computer Society of the Institute for Electrical and Electronic Engineers, Professor Stanton A. Glantz of the School of Medicine at the University of California, San Francisco, asserted:[34]

"The evidence that these (computer based) systems are doing patients any good is often very thin.....It's immoral to make consumers foot the bill for increasingly complex and costly gadgets until they can be proven effective."

Computers, like so many other promising technologies, have been used by the hospital industry in unforeseen ways, driving up costs despite their productivity-enhancing features. The cost containment problem is a many headed Hydra, but most observers are confident that computers will play an important role in its solution.

CHAPTER III

METHODOLOGY

A. Introduction

Most of the information which is vital to patient care today is generated and processed within a local area about that hospital. Hospitals tend to be autonomous institutions. It is easy to become convinced that hospitals are not attractive candidates for private-line communications service.

Most individuals in the hospital industry are unaware of significant requirements for improved telecommunications service. The telephone, mail, and automobile handle their present needs very well. Even the possibility of low cost video teleconferencing service will touch off few sparks among a random sample of hospital employees who are thinking about the question for the first time. The annual travel budget of most department heads PSSC interviewed is less than $500. It is no problem to travel to the the meetings which these people now attend regularly.

Nonetheless, the underlying hypothesis of this study was that improved telecommunications would be highly beneficial to hospitals. PSSC was not sure what services would be most valuable, but it was confident that a careful analysis of the functional requirements of four well managed hospitals would strike paydirt. The questions were: How to discover the most significant applications of external communications service and measure their value? How could one provide adequate orientation to the experts who would evaluate the possible impact of advanced telecommunications on hospitals without biasing their value judgments?

B. Forms of External Communication Activity

It is helpful to know where the external activity concentration points are located before one begins a survey of this nature. Information

flows to and from these locations can occur in six different ways: via voice, data, facsimile, imagery, mail, or meetings. An objective of this study was to document the information flows to and from these major nodes, identifying function, required performance, cost, volume, and frequency of use.

The communications manager of a large corporation usually can identify the external activity concentration points of each division. This person often can provide most of the useful quantitative information likely to be obtained regarding the present telecommunications activity and expenditures of that corporation.

Such is not the case in an average hospital. The external activity concentration points were not known at the time each hospital was surveyed. It was known, however, that hospitals communicate frequently with third-party payment agencies, doctors' offices, doctors' homes, service vendors, equipment suppliers, other hospitals, professional societies, medical schools, professional services review organizations, health service agencies, and other regulatory bodies. (See Figure 8.) They also communicate with former patients and the families of present patients, but this traffic was known to be random.

The process of obtaining data regarding voice, data, facsimile, imagery, mail, and meetings is straightforward but tedious. In the case of voice, data must be gathered regarding toll, WATS, private line, and PABX service. Mail and meeting activity can be sampled readily given time and patience. The hospitals which PSSC surveyed had relatively simple data communications requirements and did not use facsimile or televisual services of any kind.

In obtaining the necessary information, PSSC received excellent cooperation from the participating hospitals. The sample size was limited so as not to make undue demands on hospital staff resources, which were provided voluntarily.

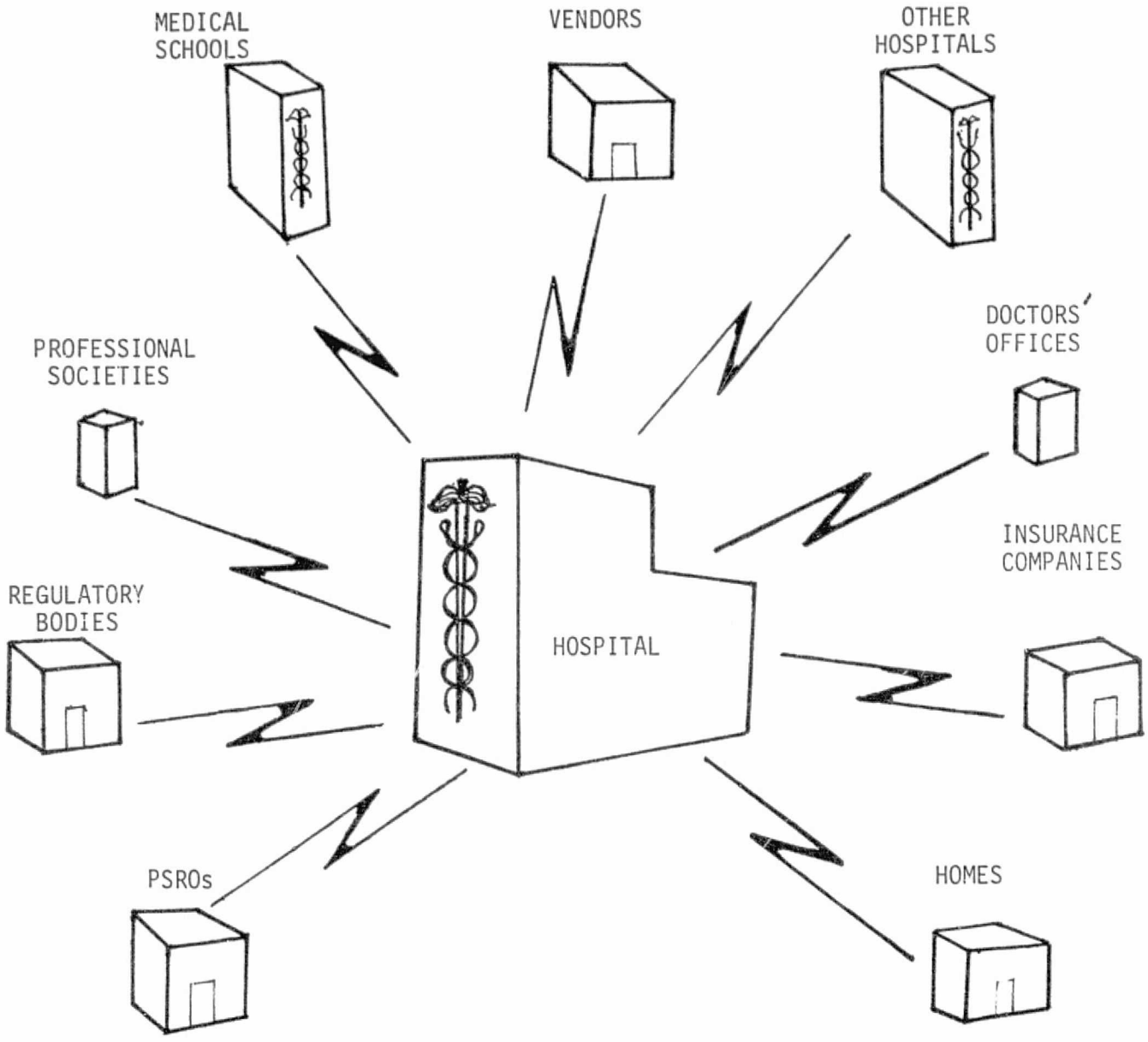


Figure 8. Forms of External Communication Activity (Voice, Data, Facsimile, Imagery, Mail, or Meetings)

C. Value of Improved Communications Service

The value of improved communications to a hospital arises from one of four factors: lower cost of existing operations; higher quality of existing services; access to new services; or expansion into new markets. Only the displaceable cost issue is readily quantifiable. But because PSSC was not offering specific alternatives to present services, even this issue could not be addressed adequately. PSSC limited itself to compiling activity levels and expenditures for present external communications modalities. For the two 400-bed hospitals which are leasing telephone service from the telephone company, however, PSSC evaluated the economic feasibility of a Private Automatic Branch Exchange (PABX).

External communications could improve the quality of health care delivery by making certain clinical procedures or specialized skills more readily available. Quality of care also could be enhanced if communications were used to gain access to outside educational materials for patients, staff, and physicians. The new services made possible by external communications might generate additional revenue to the hospital or improve its image with the physicians and community. A private network might enable a system of hospitals to eliminate unnecessary duplication of facilities or personnel.

To gain a qualitative measure of the value of improved communications, PSSC relied upon decision makers within the five hospitals surveyed. In some cases a quantitative measure of value was estimated during the interviews, using a series of "what if" questions. It was necessary for the interviewer to have substantial knowledge of possible applications of communications within the area of expertise of the interviewee to guide the discussion into fruitful areas.

D. Applications of External Communications in Hospitals

PSSC assembled a list of applications of communications prior to the start of the interviews. This list initially was compiled by Dr. Thomas E. Terrill of Akron City Hospital and James H. Brown of Satellite Business

Systems. Dr. Terrill is a hospital administrator who is Director of Medical Affairs at Akron City Hospital and Associate Dean for Clinical Sciences at Northeastern Ohio Universities College of Medicine. Mr. Brown has a background in data processing and previously was director of IBM's TRIMIS program, which involved the design of a medical information system for joint use by the Army, Navy, and Air Force. This list was expanded through conversations with industry experts.

The list is organized according to departmental function and application, and there is some repetition of applications. For each application PSSC attempted to determine how often the capability would be exercised during the course of a month, whether an existing function would be displaced, and what each application of the service would be worth to the hospital.

- Administration

1. Facilities Planning
   a. Establish amortization rates for capital equipment to maximize profitability
   b. Schedules for expansion or contraction of number of beds in service
2. Financial Planning
   a. General Ledger
   b. Budget preparation; optimization of cost allocations for reimbursement by third party agencies
   c. Planning service mix for profitable operations when there is prospective reimbursement. (Which admission diagnoses should be served? Which age groups? Which should be referred elsewhere?)
   d. Establishing guidelines for desired mix of Medicare, Medicaid, private insurance, prospective reimbursement patients
   e. Establishing rate schedules; coordination with Marketing and Operations departments
3. Fund Raising

4. Marketing
   a. Demographic analysis of population being served by hospital
   b. Demographic analysis of population trends in community
   c. Analysis of trends within physician population
      (1) Changes in facilities utilization by medical staff
      (2) Specialists moving into and out of community
   d. Trends in inpatient diagnostic categories against local history and national patterns
   e. Trends in facilities utilization (e.g., inpatient, outpatient, length of stay, revenue mix) versus local and regional averages
5. Personnel
   a. Storage and retrieval of personnel records
   b. Access to central data bases for reference checks of prospective employees
   c. Computer-assisted planning procedures to assemble costs and benefits of alternative benefits packages and insurance plans
   d. Coordination of job descriptions and salary levels between elements of a multiple-unit system
   e. Planning of career trajectories for employees of a multiple-unit system
6. Policy Formulation: Teleconferences in Lieu of Travel
   a. Less expense for current meetings
   b. Greater availability of key resources for brief appearances at meetings (e.g., lawyers, department heads, physicians)
7. Productivity Analysis (Comparative data regarding FTEs per unit of service)
8. Scheduling of Facilities and Personnel

- Admitting
  1. Admissions, Discharge, Transfer Data
     a. Immediate retrieval of basic patient information for repeat patients (e.g., birth date, sex, insurance company, religion, dates of past visits to hospital, etc.)
     b. Better coordination with other departments regarding scheduling and utilization of facilities

2. Insurance Eligibility
   a. On-line access to third-party payment agencies for information regarding limits of coverage
   b. Indication to patient at time of admission of his probable financial exposure. Some patients may elect to defer discretionary treatment or make immediate financing arrangements with the hospital
3. On-line Access to Patient Index; consolidation of records

- Business Office
  1. Accounts Receivable
     a. On-line order entry system will improve interim billing procedures
     b. On-line eligibility verification system and on-line order entry system will permit preparation of a bill at the time of discharge
     c. On-line communication with third-payment agencies will reduce Days of Revenue in Accounts Receivable. Will verify appropriateness of suggested billing procedure immediately.
  2. Accounts Payable
  3. Physician Billing (a useful planning tool)

- Clinical Laboratory
  1. Multiphasic Screening
     a. Systematic use of capability by inpatients and outpatients to lower costs
     b. Periodic testing of general population from doctors' offices and nurse practitioners' offices
     c. Use of remote terminals and sensors in schools and businesses as part of group insurance business
  2. Results Reporting
     a. Better coordination with other hospital departments and doctors' offices
     b. Immediate information from external laboratories
  3. Shared Facilities and Expertise
     a. Sensors at hospital which send information for interpretation at external service bureaus
     b. Workload smoothing
     c. Consultation with human experts

d. Digital image transmission for specialized analysis of clinical or pathological samples

4. Storage and Retrieval of Test Results

- Dietary
  1. On-line order entry will reduce waste in scheduling of meals.
  2. Support of inpatient education activities regarding proper nutritional habits in conjunction with materials generated by external parties such as the American Dietetic Association

- Education
  1. Access to remote experts, computers, and libraries of printed matter, audiovisual materials, and computer programs
  2. Central files to certify completion of program
  3. Ability to preview educational materials

- Maintenance
  1. Through use of microprocessors and telemetry, eliminate preventive maintenance of expensive equipment
     a. Use central depots to aggregate spare parts and trained technicians.
     b. Use local minicomputer to determine when equipment no longer is operating within specified limits.
  2. In general, treat the physical plant as a patient and use multiphasic screening techniques.

- Medical Care Evaluation
  1. Comparative performance information based on input obtained from Uniform Hospital Discharge Data Set (e.g., PAS, MR[11], HUP, QUEST, etc.)
  2. Medical audits, using criteria supplied by PSROs or medical staff

- Medical Data
  1. Quick retrieval of morbidity/mortality rates vs. contemplated procedures
  2. Availability of organs, blood, and other services
  3. Other accumulated medical data from Center for Disease Control, National Library of Medicine, etc.

- Medical Records
  1. On-line access to patient index; consolidation of records
  2. On-line access to patient records, including treatment rendered at other institutions
  3. Central transcription service, accessible by radiology, pathology, and doctors' offices
  4. Medical records abstracts. Electronic transmission of standard discharge forms, such as ICD-9, to service vendors such as McAuto and Commission on Professional Hospital Activities

- Medical and Surgical Staff
  1. Remote consultation and diagnosis
     a. Interaction with remote specialists, including access by remote specialist to patient's record
     b. Computer-aided diagnosis, which incorporates the latest medical knowledge
     c. Assistance in selection of treatment procedure, based on patient record, vital signs, and morbidity rate and mortality rate of alternative procedures
  2. Access to remote service bureaus for noninvasive testing
  3. Administrative support for billing, transcription, accounts receivable, word processing, investment counseling, etc.
  4. Continuing education
     a. Browsing through medical literature
     b. Access to seminars
     c. Computer-assisted instruction

- Nursing
  1. In-service training
  2. Patient education
  3. Patient monitoring
  4. Staff scheduling
  5. Workload smoothing (with other cooperating hospitals)

- Pharmacy
  1. Order entry

a. Inventory control/purchasing

b. Accounts Payable

c. Accounts Receivable

d. Labeling

2. Results reporting

a. Coordinated group actions involving other departments (especially nursing, clinical labs, dietary, business office, medical staff)

b. On-line access to patient's drug profile

3. Drug interaction support

a. Access to continuously updated information regarding drug testing, dosage levels, and drug interactions

b. Coordinated actions directly affecting patient care, using data supplied by other hospital departments (medical staff, nursing, clinical labs, plus other pertinent data regarding the status of the patient) to determine proper sequence of drugs and proper dosage levels)

- Purchasing/Materials Management

1. Inventory control

2. Group purchasing; teleconferencing in lieu of travel for meetings to form necessary consensus on products and services

3. Review of product and service alternatives via teleconferencing techniques involving potential suppliers or existing customers

- Radiology

1. Shared instrumentation (CT scanners, ultrasound, other noninvasive test equipment)

2. Consultation

3. Image enhancement

4. Storage and retrieval of radiological images from central files

E. Survey Process

The study schedule is shown in Figure 9. It began in June 1978 and was completed in April 1979. The most difficult periods were between June and August 1978 when the methodology was being developed, and between January and March 1979 when the data was collected and analyzed. The period September

through December was devoted primarily to background reading and interviews with experts to prepare for the site surveys.

The interviews were conducted by Ms. Polly Rash and Dr. James G. Potter of PSSC's staff, neither of whom were experts on hospitals or data processing. They were trained to conduct the interviews by Dr. Tom Terrill, PSSC's principal consultant on health care and a hospital administrator, and by SBS.

PSSC spent two weeks at a test hospital site validating the survey methodology. It was not clear what individuals on the hospital staff would be most helpful in describing the feasibility and value of improved telecommunications service. PSSC had the full support of the Executive Director of the hospital and free access to data and personnel. A total of 38 interviews were conducted. It was discovered in retrospect that most of the significant information could have been obtained in six to ten interviews.

PSSC surveyed four hospitals of a multi-institutional arrangement. These hospitals are not owned by a single corporate entity, but all subscribe to a number of services from one contract management firm. PSSC interviewed the leadership of this firm and with their help selected a sample of four well managed hospitals. PSSC's liaison at the management services firm wrote to the Executive Director at each of these hospitals, who agreed to participate in the study. The Executive Director selected a liaison for PSSC, who scheduled the interviews and was accessible to PSSC during and after the site survey for additional information. The ideal liaison person is highly placed in the organization, fully supportive of the study, and willing and able to discuss where the skeletons are buried.

PSSC spent three days at each of the four hospitals interviewing six to eleven people. On the morning of the first day PSSC conducted a one-hour orientation session for all who would be interviewed, covering much of the material of Chapter II of this report. Generally, PSSC conducted the interviews from the top down, beginning with the Executive Director whenever possible.

Figure 9. Study Schedule

Date	Milestone	Other Inputs
June, July	1. Goals, Objectives	NASA, SBS
July	2. MOU with SBS	
June July	3. Study Design -Preferred Sites -Draft Methodology	NASA, American Hospital Association
August, September	4. Test Site Validation	Participating hospital
October, December	5. Finalize Site Selection, Refine Methodology	NASA, Industry experts
January, February	6. Conduct Survey	Participating hospitals
March	7. Conduct "Discovery" Sessions	Selected interviewees
March, April	8. Analyze Data	NASA, Industry experts
April	9. Final Presentations and Report	NASA

Interviews lasting up to ninety minutes were conducted with the Executive Director and department heads in the Business Office, Data Processing, Purchasing and Materials Management, Medical Records, Pharmacy, Radiology, Clinical Laboratory, and Staff Training. In some cases, PSSC interviewed the Director of Nursing and the physician responsible for Continuing Medical Education. PSSC encouraged the interviewees to use their imagination and intuition in answering the questions, and generally this process worked best when there were two interviewers and one interviewee. PSSC's liaison at the hospital usually obtained the data required to evaluate present voice, mail, and meeting activity.

PSSC interviewed a number of physicians at the test hospital but found that outside of educational activities they had very little interaction with external parties and had given little thought to the need for improved external communications. To validate the findings of this study, it will be necessary to gain considerably more physician input. The Medical Staff, along with Administration and the Board of Directors, generally sets policy in a hospital.

Before each interview, PSSC reviewed the communications applications which were likely to be of greatest value to the interviewee and attempted to conceptualize a series of "what if" questions which might shed quantitative light on the value of these applications. The ninety-minute interview was broken into four parts, the first of which defined the interviewee's area of responsibility; the second of which was designed to understand the importance and adequacy of present forms of communications to his department; the third of which reviewed the capabilities of advanced communications (which had been described in the orientation session) and solicited new ideas from the interviewee regarding possible applications; and the fourth attempted to identify the most important applications, describing the benefits as precisely and completely as possible. Generally speaking, these interviews were thought provoking and enjoyable for the participants. Those individuals who could think of a number of promising applications often did not want to stop after ninety minutes. For many people, however, one hour was more than sufficient to complete the interview. The list of questions asked during the interviews appears in Appendix A. A questionnaire which most of the interviewees completed regarding present activity involving telephone, mail, data processing, and meetings appears in Appendix B.

After the interviews were completed and documented, PSSC analyzed the results, identifying the most promising applications by communications modality. The results were somewhat disappointing at this juncture. Although the interviewees were intelligent and favorably disposed to the objectives of the study, most were preoccupied with today's problems and unable to place them in perspective. At this point, two structured,

interactive "discovery sessions" were conducted, one with selected interviewees from the management services firm and a second with representatives of the five hospitals that had been surveyed. These sessions were moderated by Mr. James H. Brown of SBS, who has considerable experience with this approach and has the knowledge and self discipline to guide the discussion into promising areas without biasing the outcome. After a "warm up" period to allow the participants to become comfortable with one another and with the subject matter, they were asked to list on 3 x 5 cards the five most promising new applications of telecommunications in health care in the period 1980 to 1990. The probable cost of the necessary communications or computer power was not to be a consideration, nor were the possible complexities of making the necessary institutional adjustments. If the application did not violate the laws of physics and did make sense, it could be considered fair game.

After listing these most promising applications, the participants discussed the pros and cons among themselves. Each participant then ranked all the applications which had been suggested by the group, assigning five points to his first choice and one point to his fifth choice and zero to all applications that were not in his top five. The weights were then added, and those with the highest totals are discussed in Chapter V. The participants then discussed the problems and opportunities that would influence implementation of the most promising applications, a commentary which is summarized in Chapters VI and VII.

These "discovery sessions" proved to be extremely helpful. They served to place the mass of information which had been collected by PSSC into perspective. Research has shown, in fact, that individuals who are attempting to form judgments about an unstructured situation and to forecast outcomes perform better as a group than as individuals.[35] The average performance of this group, in fact, tends to be much better than the average performance of the best individual in the group. This research provides objective evidence for faith in the "Delphi" technique.

F. Site Selection

PSSC chose to analyze four well managed hospitals from a prominent multi-institutional arrangement. By agreement, the name of the system and the individual hospitals shall remain anonymous.

Two of the hospitals each have approximately 400 beds and annual revenues of about $35 million, and two have about 170 beds and annual revenues of about $14 million. The hospitals of the multi-unit system are geographically dispersed and nonprofit. They all subscribe to a number of services, including data processing, from a for-profit management services firm.

Each hospital that agreed to participate in the survey voluntarily provided PSSC with access to their key personnel for a substantial period of time. In return, they gained added perspective regarding their telecommunications options in the 1980s, which may or may not impact on their Business Plans. They gained no immediate relief from their many pressing problems.

PSSC is grateful for their support. This study would have been impossible without it.

CHAPTER IV

PRESENT TELECOMMUNICATIONS ACTIVITY AND EXPENDITURES

A. Telephone

The principal communications requirements of a hospital today appear to be in the areas of standard telephone service, paging, and transcription service. The call activity overwhelmingly is confined to a local area about the hospital. Typically there are two distinct telephone systems in a hospital, one for the patients and one for the staff. A hospital does not want patients to be able to call doctors or staff directly. Generally, the hospital, at its discretion, is able to permit Direct Inward Dialing (DID) to a patient's room or to intercept the calls at a central switchboard.

The annual telephone expenditures (exclusive of operators) of a 700-bed hospital that was surveyed by PSSC are itemized below:

(1) Total	$318,448	
(2) Long Distance	40,060	
(3) Interstate Long Distance	10,362	(26% of above)
(4) Intrastate Volume	308,086	(Line 1 minus Line 3)
(5) Intrastate Volume within local area code	254,131	(80% of above)

One of the 400-bed hospitals surveyed by PSSC handles an average of 13,000 calls a day at its switchboard. The majority of these calls are local. The two 400-bed hospitals surveyed each spend about $18,000 a month on telephone service, and the smaller hospitals spend about $4,100 a month. The only advantage to hospitals of a system which provides least cost routing tends to be in dialing foreign exchange lines to residential areas which are preferred by the medical staff.

CHAPTER IV

A description of the information flow of a 170-bed hospital which was surveyed by PSSC appears in Figure 10. No data regarding incoming call activity was obtained. The figures include all telephone numbers which were called at least twice in a month selected at random. All of the outgoing toll calls that were called only once were assumed to be random and not to be destined to the activity concentration points which are identified in Figure 10. Each hospital of this system leases two 2400 baud lines for batch processing services and an on-line patient-index service which is rendered by the management service firm.

One of the 400-bed hospitals leases Centrex service from the local telephone company. PSSC performed an analysis to evaluate the economic feasibility of a purchased Private Automatic Branch Exchange (PABX). Included in this comparative evaluation were the following items:

(1) Main Switching Equipment - The major part of the telephone system which connects the trunks to stations and stations to stations. It must have sufficient capacity to provide for projected ten-year growth.

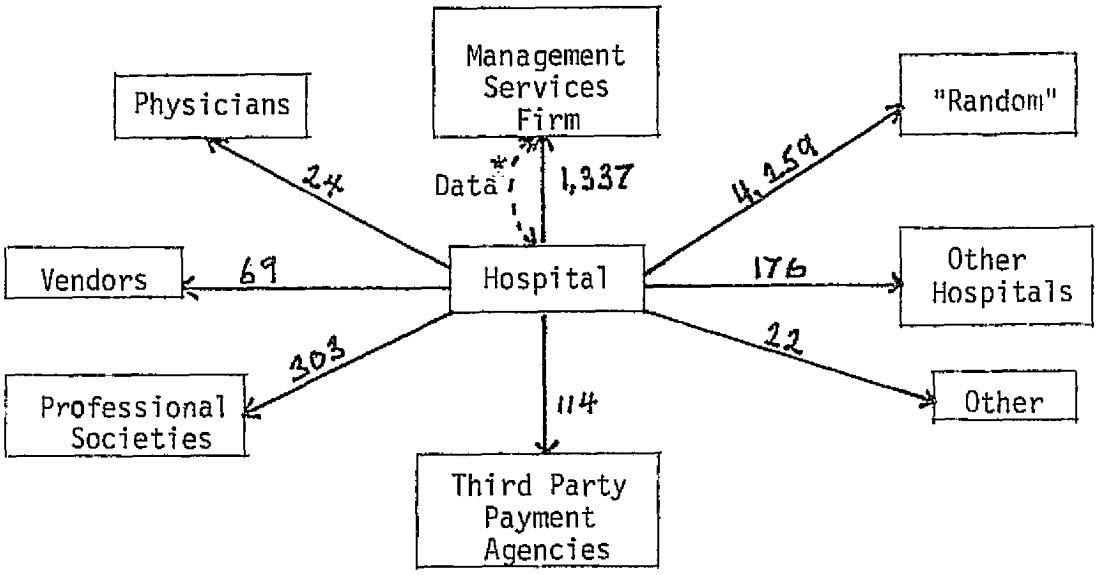
(2) Station Equipment - "Key" telephone service units are now used. Because of the advanced features provided in a purchased telephone system, complex telephones frequently can be replaced with single sets, thereby reducing overall costs. However, no such reduction was projected in this comparative evaluation.

(3) Peripheral Equipment - The equipment records were examined to identify those items that would have to remain even if a purchased system were installed. The cost of paging service was deducted from the equipment bill, thereby reducing the monthly equipment charge from $11,990 to $10,855 for purposes of comparison.

(4) Rate Increases - Historically, telephone company PABX systems have increased at a rate of 7% per year. Centrex has increased at an even steeper rate; but for purposes of this evaluation, 7% was used to project annual cost increases for the existing telephone system.

Figure 10

Outgoing Toll Telephone Traffic from a
170 Bed Hospital (Call Minutes Per Month)



*Two 2400 baud leased lines are used by the hospital to transmit low speed data to and from the management services firm.

(5) Purchase, lease-to-buy, or true lease arrangements are financing options for a purchased system, each having its advantages and disadvantages. For this comparison, a $526,000 purchase price was amortized over seven years at an interest rate of 12%, yielding equal annual installments of $115,256 for a seven-year period.

(6) Trunking Costs - In order to provide Centrex features on the purchased system, 400 DID numbers and 80 trunks were provided. Montly costs amount to $750. A one-time installation cost of $3,340 appears in first-year costs.

(7) Adding or Removing Equipment - No attempt was made to calculate the costs of adding equipment, but it is assumed that the costs are proportional to a total system cost. There is no cost to remove

equipment from the telephone company system. Monthly charges simply stop. Neither is there a charge to remove equipment from the private system. The equipment is simply stored.

(8) Basic Termination Charges - The telephone company assesses a penalty if a PABX system is removed before a five-year period has elapsed. This five-year period expires for the hospital in February 1980 except for one additional console that was added in 1978. Assuming that a new system would not be installed until February 1980, the penalty charge remaining would amount to $540. This amount has been added to the cost of the purchased system in Figure 11.

(9) Maintenance Services are included with the rental costs from the telephone company. There are three options available for the purchased system: Hire a maintenance person; pay a service company on an as-needed basis; or sign a full service, not-to-exceed contract with a service company.

The third and most costly option has been assumed for this evaluation. No service charges are incurred in the first year, however, since the purchased system would be covered by warranty. This grace period gives the customer an opportunity to decide on the best maintenance option. In subsequent years, maintenance costs for the purchased system are estimated to average $2 per telephone per month, or $1,400 per month, increasing at 7% per year after the second year.

(10) System Modification Services - No attempt was made to calculate the costs of modifying, adding, or removing equipment. These costs are approximately the same for leased or purchased system service.

(11) Tax Considerations - Typically there are numerous tax advantages in a purchased system, but since the hospital is tax exempt, this was not a factor in the evaluation.

(12) Floor Space - The present Centrex system uses very little floor space since most of the equipment is housed in the telephone company's central office. A purchased system also requires very little floor space, about 200 square feet for an 850-line system capacity. No cost was assumed for this space.

(13) Number of operators required is not expected to change with the installation of a purchased system, even though the purchased system has features that should relieve operator work load.

(14) Toll and message unit costs are not calculated to change in this evaluation, although the purchased system has features that should reduce toll costs.

Figure 11

Economic Comparison of Telephone Company vs. Private Branch Exchange for a 400-Bed Hospital. (Thousands of Dollars)

	Telephone Company		Purchased System			
Year	Annual Cost	Equipment Cost	Trunking Cost	Maintenance Cost	Total Annual Cost	Annual Savings
1	$130	$115	$13	$incl.	$128	$ 2
2	139	115	9	17	141	(2)
3	149	115	9	18	142	7
4	160	115	9	19	143	17
5	171	115	9	21	145	26
6	183	115	9	22	146	37
7	195	115	9	24	148	47
8	209	-	9	25	34	175
9	224	-	9	27	36	188
10	239	-	9	29	38	201
10-Year TOTALS	$1,799	$805	$94	$202	$1,101	$698

The estimated savings amount to $698,000 over the presumed 10-year life of the equipment, and this solid-state equipment should continue to provide reliable service for at least 15 years. The purchased system would also provide additional features not available on the present Centrex system, such as touch-tone dialing, paging flexibility (selected stations in critical areas could be equipped for paging), call pick up (whereby a ringing telephone can be answered by any other station in the area by dialing a code), speed call (which enables frequently dialed numbers to be accessed by a one or two digit code), and busy line call back (whereby the number is redialed upon command until the call is completed).

The cost effectiveness of a PABX system tends to be more dependent on the hospital's location than its size. The location determines not only the serving telephone company (and to some extent the rental rates) but also the availability of competent private system suppliers. Hospitals having as few as 100 beds can benefit economically from a private system. Three other factors which tend to make private systems attractive to hospitals are better control over expenses and grade of service (hospitals can perform their own maintenance) and the availability of least-cost routing, which permits those calls that could be routed most economically over private communications lines to be sent automatically in this fashion. The least cost routing algorithm can be reprogrammed in response to changing tariffs and service offerings.

B. Mail

Figure 12. Summary of Mail Activity of a 700-Bed Hospital

The average monthly outgoing mail activity of a 700-bed hospital surveyed by PSSC is itemized below:

Class	No/Month	Cost/Month
First Class	15,195	$2,188
Certified	56	118
Insured	21	38
Registered	5	17
Express	13	96
Bulk	5,364	194
TOTAL	20,654	$2,651

A flow diagram of the average daily mail activity of a 400-bed hospital and a 170-bed hospital that were surveyed appears in Figure 13. The Activity Concentration Points observed in Figure 10 regarding telephone activity again are apparent. The 400-bed hospital spends about $5,220 a month on mail, and the smaller hospital spends about $2,220 a month. Note the average monthly mail expenditures of the autonomous 700-bed hospital ($2,651) is surprisingly low, reinforcing the impression that autonomous hospitals tend to be islands unto themselves.

The mail statistics of Figure 12 for the 700-bed hospital are based on three months of data, whereas the statistics of Figure 13 are based on three days of data. Thus comparisons may be misleading

The management services firm used by the hospitals of the multi-unit system surveyed operates a courier service which provides overnight document delivery from mail room to mail room of participating hospitals. Curiously enough, it now often takes several days for documents to reach their intended recipient from the mail room of this firm.

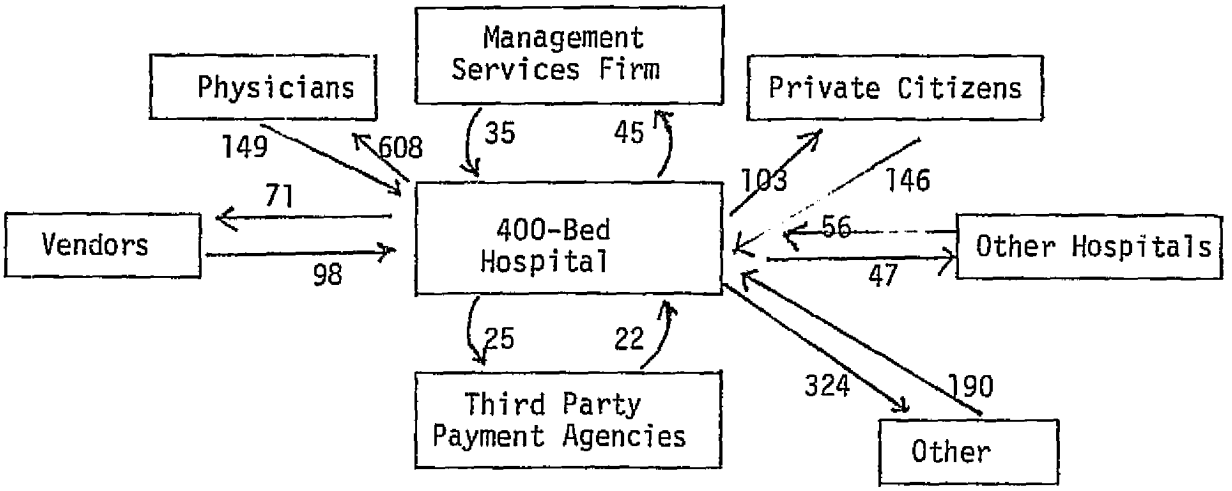
C. Travel, Meetings, and Training Activity

A somewhat misleading sample of the travel activity of the management services firm appears in Figure 14. PSSC reviewed the travel vouchers from the agency handling this firm's account over a three-month period, and the results are displayed. It was not clear from the information available to PSSC what the destinations of the trips were, so educated guesses were made. Conspicuously absent from the vouchers examined by PSSC was evidence of trips taken by the most senior level personnel of the management services firm, who were known to travel frequently. Also, much of the travel to client hospitals is by automobile.

In the course of the interviews, it became apparent that senior level personnel of each hospital in this system meet together on an average of twelve person-days a month. That is, the executive directors meet once a month, and department heads in such areas as Materials

Figure 13

First Class Mail Volume (Letters per Business Day)



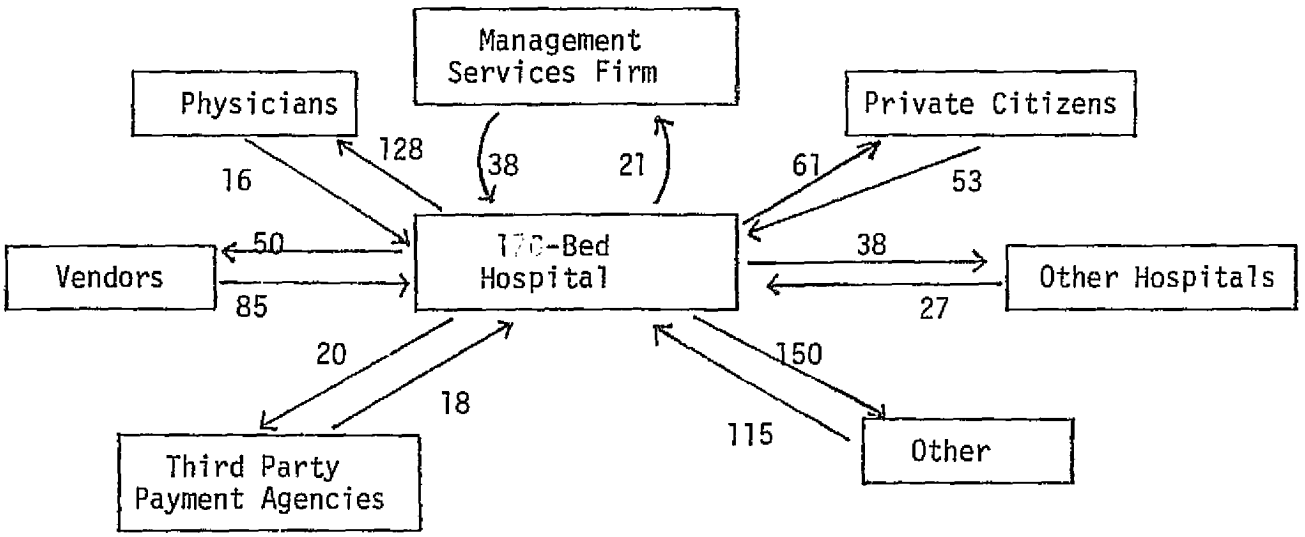
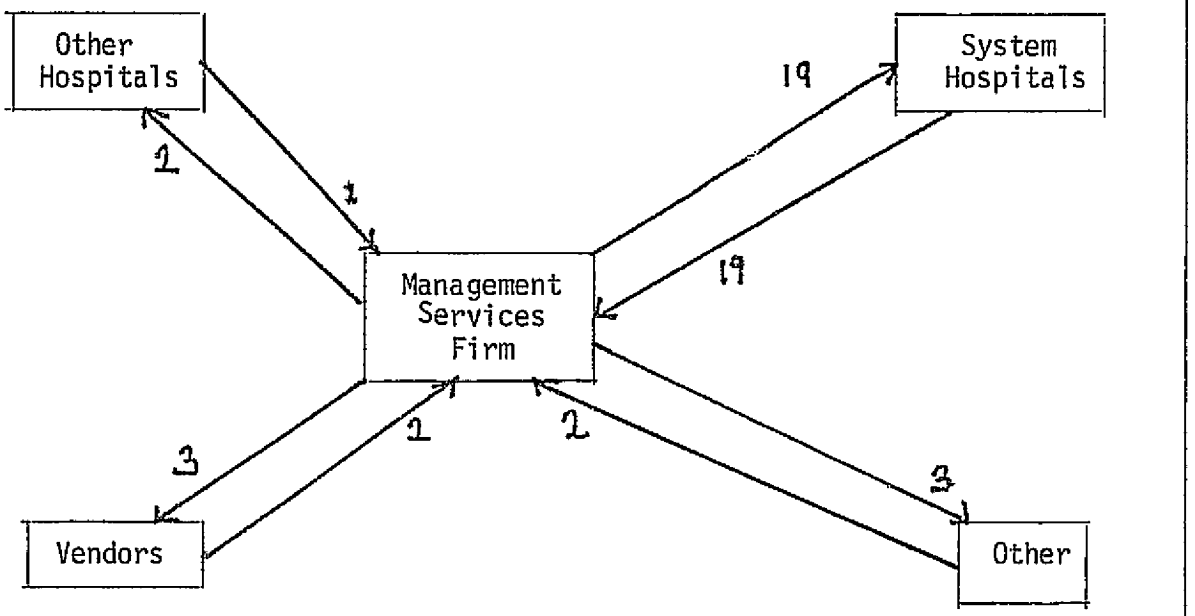


Figure 14
Monthly Air Travel Volume Initiated by Management Services Firm
(Round trips per month)



Management, Pharmacy, Data Processing, and Nursing meet with their counterparts with varying frequency, which averages out to be twelve person-days a month of outside meetings. The value of a video teleconferencing service is calculated in the next chapter.

The total travel budget of each 400-bed hospital is now about $5,000 a month, whereas the 170-bed hospitals are now spending about $1,200 a month.

Although PSSC made a conscious effort during each interview to obtain quantitative information regarding present levels of training activity in the hospitals surveyed, no one seemed to have good information. The

executive director of one of the smaller hospitals, who recently created a department which is responsible for hospital-wide training (exclusive of the medical staff), attempted to obtain accurate data on this subject in the last year. His analysis of the time cards of his staff revealed that the hospital was allocating about 1.2% of total expenditures on training activities. When he looked more closely into the situation, however, he found that many department heads were padding this expense category because it was exempt from the productivity studies which the hospital performs under the auspices of the management services firm. The departments of each hospital in the system are compared on the basis of FTEs per function, weighted by the number of beds, and executive directors take this comparative efficiency information seriously. To conclude, the executive director is still not sure what his hospital is spending on training activities.

PSSC was dismayed by current attitudes toward training. Employees were discouraged from traveling out of state to attend a conference. In one hospital, until recently, individuals were required to take vacation time to attend local seminars.

A Director of Nursing informed PSSC that perhaps 5% of her R.N.s would be interested in outside materials that would elevate their general awareness of trends in medicine. Most nurses were strictly interested in "how to" information that would help them improve their job performance NOW.

While the indications are ambiguous, PSSC estimates that hospital employees now spend between 1% and 3% of their time engaged in all forms of training activity, including general orientation functions.

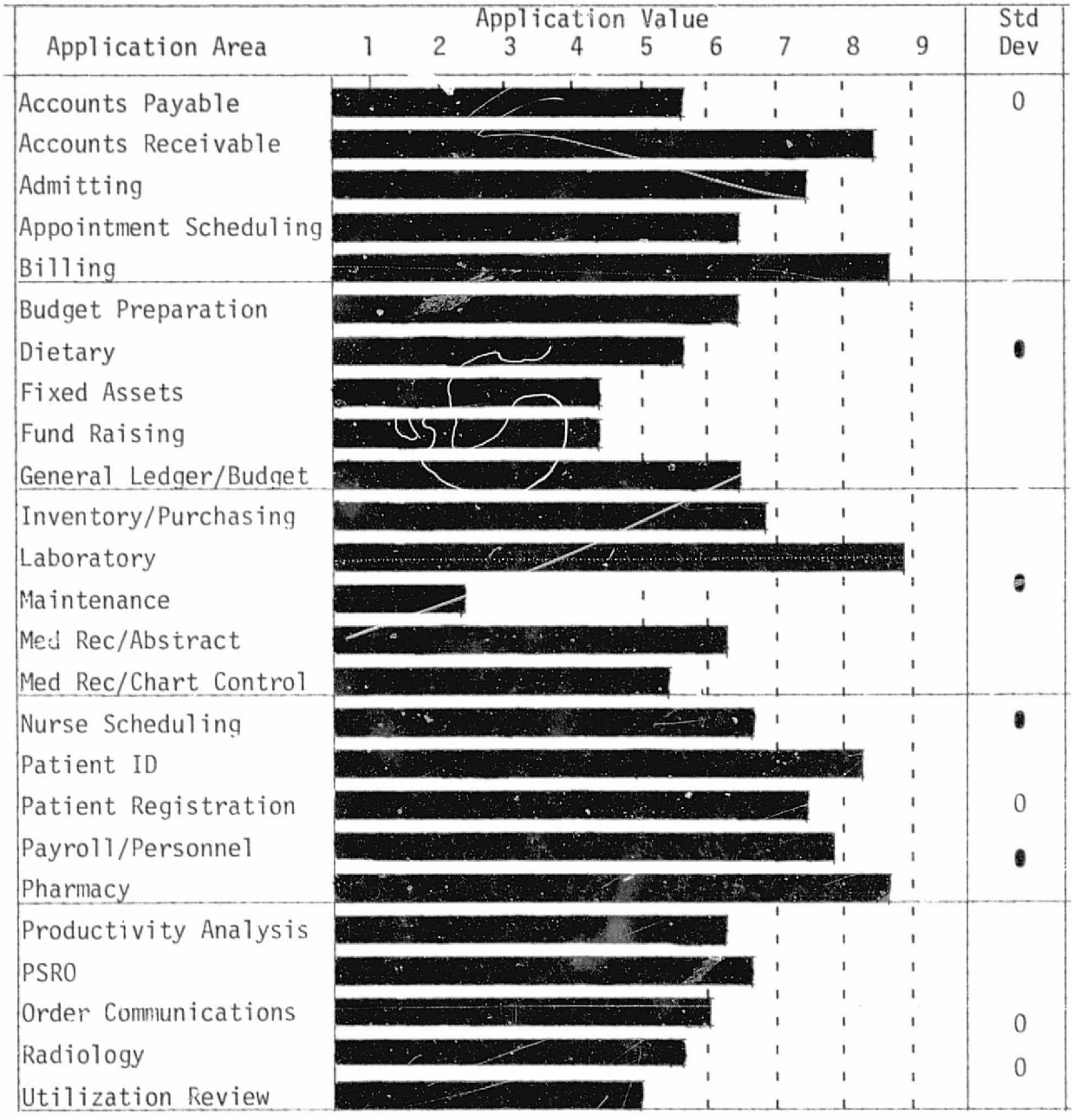
D. Imagery and Facsimile

Present expenditures in these categories are negligible. PSSC is not including present internal radiological activities in making this statement.

E. Data Processing

The D.P. Management Corporation in 1976 surveyed the data processing environment of 10 hospitals which were members of the Electronic Computing Health Oriented (ECHO) organization. Experts were asked to rank the relative value to the hospital of 25 promising computer applications on a scale of 0 to 10. The results of this survey are tabulated in Figure 15.

Figure 15
Relative Value of Data Processing Applications[36]



Standard Deviation: ● Substantial Agreent 0 Substantial Disagreement

The D.P. Management Corporation estimated that the net benefit of extending data processing applications beyond their present narrow financial base would range from $500,000 to $1,600,000 annually in a 450-bed hospital.[37]

Surveys of the member hospitals of the system which PSSC examined are generally consistent with the findings of the ECHO study. The management services firm which provides data processing support to the hospitals is proceeding in a modular fashion. Until January, 1979, only batch services were offered, providing support for census management, inpatient billing, accounts receivable management, and other financial services, including general ledger. Client hospitals have used a 2400 baud leased line to access this batch service.

The first on-line service offered was medical records indexing. Terminals have been installed in Medical Records, the Emergency Room, and at the admissions desk and registration desk of both the inpatient and outpatient departments of subscribing hospitals. This service is helping to consolidate patient records under a single unit number. Subsequently, this firm intends to offer additional on-line services in the following order: patient registration; admission, discharge, and transfer; ancillary services, beginning with Pharmacy and then the Clinical Labs; charge-order entry; and results reporting.

This management services firm is proceeding cautiously and is making a conscious effort not to over-sell the probable benefits of the planned data processing applications. A principal benefit of these initial on-line applications is the creation of data bases which eventually will be used in a number of more advanced applications.

CHAPTER V
NEW USES OF TELECOMMUNICATIONS AND DATA PROCESSING

All of the applications listed in Chapter III are considered promising by at least two experts whom PSSC consulted during this survey. Discussion in this chapter, however, is limited to eight applications which received the highest scores at two "discovery sessions" that were conducted at the end of the study. (See Chapter III.) The applications felt to have greatest promise are: widely accessible, on-line data bases of patient records; remote diagnosis for specialist areas; point of origin data collection with input to central data bases; multiphasic health testing; video teleconferencing for administrative coordination; workload smoothing among multiple hospitals; educational support series; and assessment of the quality and utilization of health care services. Each of these applications will be discussed in sections to follow. The benefits of these applications are generally not fully understood or quantifiable at the present time.

Applications of telecommunications and data processing in hospitals today are largely limited to Plain Old Telephone Service (POTS) and financial operations. This results both from the fact that the communications resource environment is limited but also from the fact that hospitals have been relatively unsuccessful in their previous attempts to extend data processing applications to clinical operations or higher level planning and control functions. (See Chapter II.) Communications and data processing technology will improve in the 1980s, but the average hospital's ability to use these tools may not.

There will be increasing emphasis on office automation in the 1980s, a problem area for hospitals, which now allocate approximately 23% to 39% of total expenditures to information activities.[38, 39]

CHAPTER V

Developmental efforts in the private sector regarding medical information systems are likely to focus on improving administrative productivity. This work is important, but applications that could have a more direct impact on patient care are likely to remain dormant in the absence of federal R&D support.

The eight applications which appear to have the greatest potential for improving health care delivery all will make extensive use of on-line data base management systems. The information which a hospital requires to operate is retained in many different ways -- printed, typed, written, recorded, or memorized. As a result, it is usually very difficult, if not impossible, to keep track of the information available.

In a December 1978 manual concerning data bases for health care, IBM observed:[40]

"The advent of the computer did not solve this problem but in fact compounded it by duplicating more information. Creating new machine-readable records and not eliminating the old information medium became common practice, and it was not unusual to create multiple machine-readable records of the same information. This trend continued until the cost of this duplication and maintenance became so prohibitive that a more direct approach to information handling had to be found.

To cope with an environment of increasing complexity, management has had to analyze and correlate vast amounts of data. In so doing, it has become sensitive to the need for accurate, consistent, and easily available information. Since the computer assumes a large share of the burden of correlating and combining data, it is no surprise that attention has focused primarily on machine-readable information, leading to a search for a more efficient way to store and use data. This search, in turn, has led to the data base approach."

CHAPTER V

A data base is a collection of units of information organized to permit sharing among different applications and different users. The purpose of a data base is to consolidate existing data into a small number of depositories, to eliminate redundant data as much as possible, to maintain consistency between all common data elements, and to keep this data current. A distributed data base is one logical data base with elements at several locations.

Use of distributed data bases has several implications:

- There is a need for standards. Each element or unit of information must be defined consistently.
- Special purpose tools, such as data base management systems and communication systems, are required to implement physical representations which satisfy multiple needs.
- There is a need for a management agent to maintain security, keep the data bases consistent and current, and facilitate access to these data bases by multiple organizations.[41]

The participants in the survey strongly sensed that data base technology could help hospitals solve some of their complex problems, but they were not sure how or what the value of the new applications would be. The present emphasis on cost containment already is forcing the hospital industry to justify planned capital acquisitions which cost more than $100,000. Increasing emphasis on prospective rate setting will force hospitals to plan carefully what types of ailments and what types of patients should be served -- and what level of quality should be maintained. Hospitals are now ill equipped to make such judgments. Yet, erroneous rate setting could lead to multiple bankruptcies and surely will bring belated awareness to the hospital industry of the need for current, well integrated data.

A. Widely Accessible, On-Line Data Base of Patient Records

Medical information systems should perform four basic functions:[42]

- Capture data normally recorded about each patient and store it in a local data base.
- Provide appropriate access to this data base by hospital personnel.
- Support administrative requirements, such as sending messages

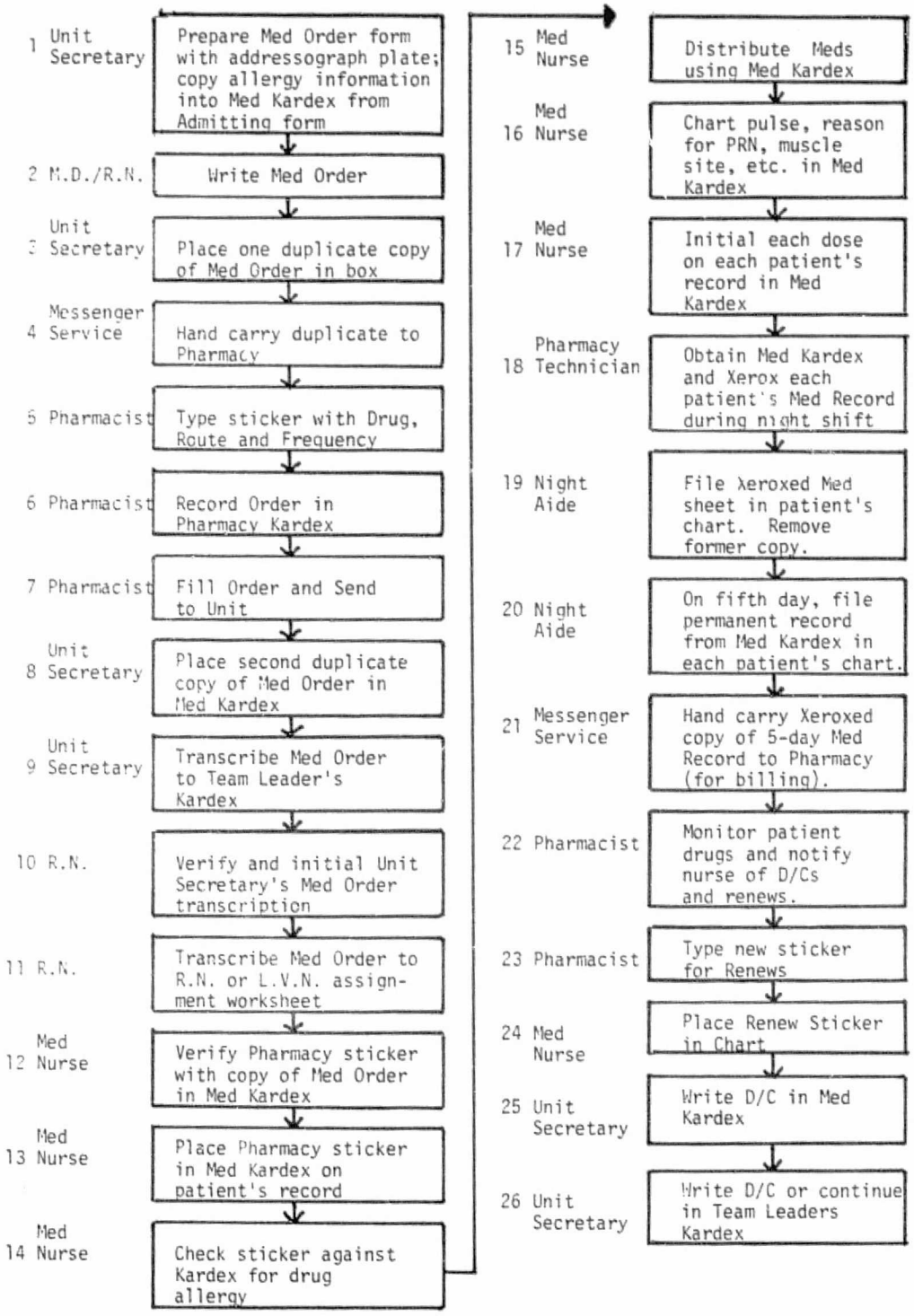
among various departments, scheduling appointments and procedures, posting charges, and preparing bills.

- Support development of national data bases to improve clinical decision making and support epidemiological and health services research.

Medical information systems reduce the errors and delays which occur regularly in a hospital. Hodge cites an example which arises when a physician orders medication.[43] While the procedure differs from one hospital to the next, the sequence described by Hodge in Figure 16 is representative. Twenty-six separate steps are involved when manual information-transfer techniques are employed, whereas the Technicon Medical Information System (TMIS) could perform this function in eight steps. (See Figure 17.) Assuming that each step is performed correctly 99% of the time, the probability of completing the order correctly is 77% in a manual system and 92% in the automated system. This example is realistic: studies have shown that medication orders are completed incorrectly 17% to 25% of the time.[44]

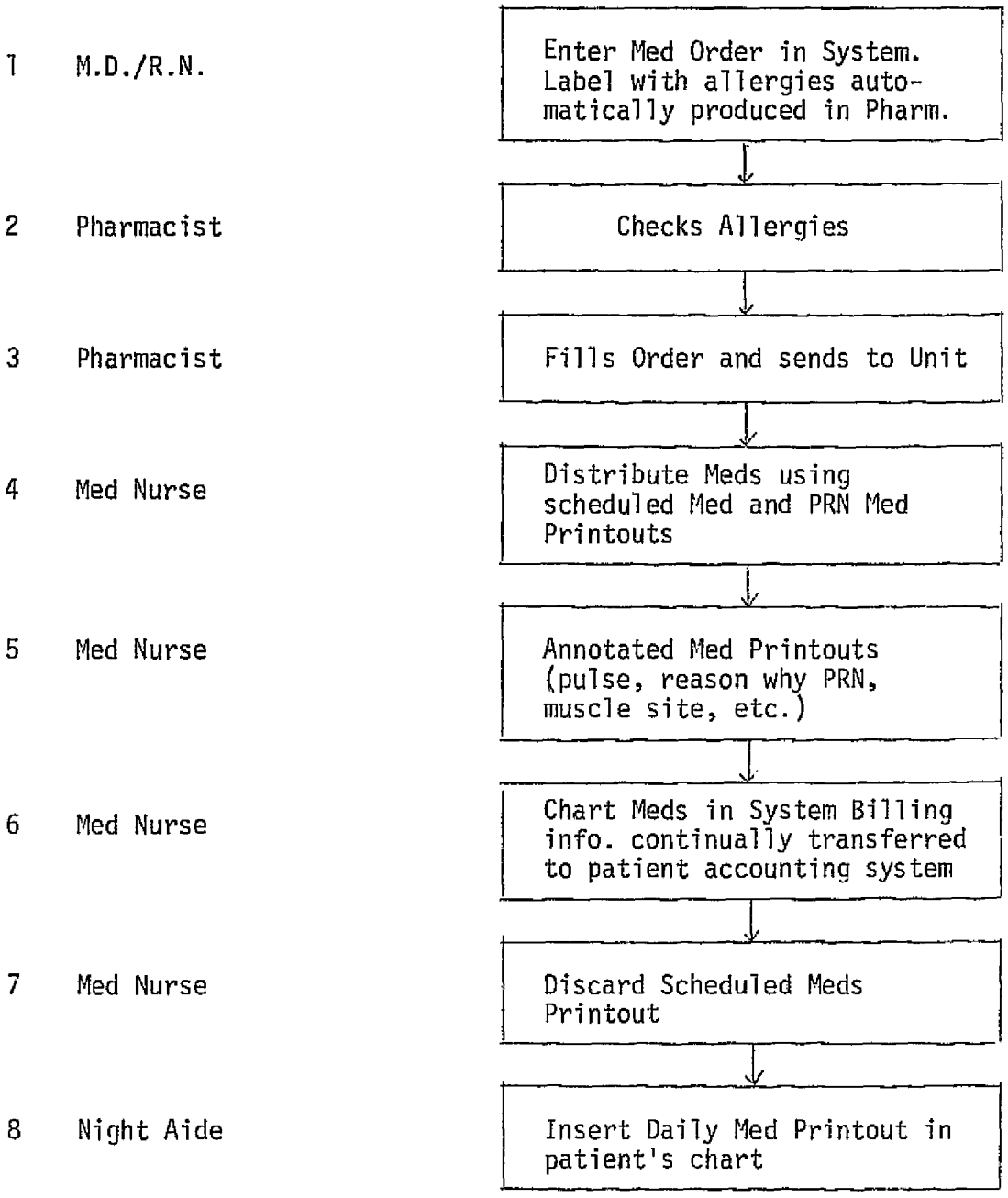
A machine-readable patient record is the cornerstone of an effective medical information system. Three systems in use today, TMIS, COSTAR, and PROMIS, each have developed their own formats.[45-47] The most interesting of these is the PROMIS format, which not only structures the medical record but directs the process of clinical care. The PROMIS Laboratory staff, under the direction of Dr. Lawrence Weed, developed this structured system to reduce dependence on the physician's memory, to provide information regarding the appropriateness of a procedure, and to facilitate continuity of care by making the record more understandable. The patient record is organized into four categories: the past medical history of the patient, a list of the patient's current problems, diagnostic and treatment plans for each of these problems, and progress notes indicating how the patient is progressing during therapy. Physicians are required to follow this format in updating

Figure 16



A Manual Medication Procedure: 26 Steps[48]

Figure 17



An Automated Medication Procedure: 8 Steps[49]

the record, which creates resistance to acceptance. Medical schools increasingly are teaching the Problem Oriented Medical Information System, however, which will reduce future physician resistance.

When the medical record is available at the time of admission, the treatment profile of the patient is immediately clear. One knows what medications the patient is taking, and often the admission diagnosis can be established without performing many otherwise routine tests and examinations. An expert source informed PSSC that lack of the patient record increases the average length of stay by three days.[50] A widely accessible data base of patient records will reduce the clinical risk and cost of medical care of a resident and transient population.

Several pharmacists whom PSSC interviewed stated that a data base containing the most up-to-date information regarding proper drug dosages and drug interactions would be extremely useful. If the service were available on-line at affordable prices, one pharmacist estimated it would be accessed about 50% of the time a medication order was received by his pharmacy department. If other diagnostic information, such as EKG data, also were available on-line for processing, this pharmacist estimated that the average length of stay of patients on antiarrhythmia drugs could be reduced by 20%, from about 20 days to 16 days. He estimated a 20% reduction in length of stay also could be achieved for patients who were receiving antibiotics for nonprophylactic reasons. This same on-line system could provide more accurate labeling, which would enable the pharmacist to provide better service to ambulatory patients.

B. Remote Diagnostics for Specialist Areas

The National Center for Health Services Research has sponsored a number of studies on the use of telecommunications in health care, with particular emphasis on rural health delivery. The appendix to reference 11 contains a summary of 48 telehealth projects. The notion of a hierarchical health care delivery system, in which patients are treated at

the lowest feasible level, has intrinsic appeal. A theoretical analysis of the potential effectiveness of telecommunications technology in helping to avert unnecessary referrals in a hierarchical system appears in reference 51. The co-author of this paper, Dr. Maxine Rockoff, noted a basic fallacy in this line of thinking, however:[52]

> *"To the extent that the cost of care increases with each level in the hierarchy, avoiding referrals reduces costs, and benefits those who pay for care, including patients and insurers. But considered from the perspective of that 'next level up' whose expertise is to be brought to the patient via telecommunications technology instead of having the patient referred to it, this may be no benefit at all. Indeed, the pecuniary interests of the 'next level up' may be best served by maximizing referrals, not minimizing them."*

Unrelenting pressure by the federal government to cap the rate of inflation in health care costs and the related tendency of health care institutions to become associated with multi-institutional arrangements is creating a more favorable climate for telemedicine. Service vendors already are doing well in such areas as cardiology and pathology.[53, 54] Dr. David Whitlock and his coworkers at the University of Colorado School of Medicine are persuaded that the capital cost of CT scanners could be reduced by 40% through use of a hierarchical system in which the sensor and display devices are located in the rural health care facility and the image processor is located at the referral center.[55] Similar economies in other areas of noninvasive testing are likely as a market for the equipment develops. Multi-unit health care delivery systems need to develop formal referral agreements to make it financially attractive for prosperous urban providers to make capital investments in telemedicine equipment at rural and inner city health care centers.

A major benefit of computer-based diagnostic systems will be improved dissemination of medical knowledge to the practicing physician.

In the PROMIS system, for example, new medical knowledge is added to the system after it is carefully researched and found to be valid. It is presented to the physician in the form of journal references and related procedures and drugs. A data base of patient records will permit rapid construction of statistically significant sample sizes of treatment profiles. The physician will be able to access complex data bases containing the latest medical knowledge by entering appropriate authentication data and the medical record of the patient. The physician could concentrate on synthesizing information, rather than memorizing facts.

A central data base of treatment procedures could be structured to provide necessary controls against inclusion of unproven therapies. The PROMIS laboratory suggested creation of a central organization having the responsibility to update the data base of medical knowledge.[56]

Telemedicine is attractive primarily because it can improve access to quality health care to rural and inner city residents. These same techniques also could open up a world market to U.S. providers. Whether increased demand for specialist services will lower health care costs is impossible to predict at this time. There are indications, however, that the time of existing medical specialists and the associated support facilities are underutilized.[57, 58] If such is the case, increased use of telemedicine may introduce economies of scale to the practice of clinical medicine.

C. Point of Origin Data Collection: Input to Central Data Base

Point of origin data collection is complementary to the concept of a data base. Ideally, data should be collected once, and thereafter duplication and dissemination of this data should be under central control. There would then be reductions in the cost of data collection and the delay and error rate of transferring data also would be reduced. Above all, the expense of unnecessary duplication of data would be reduced.

A direct application of these concepts may be found in the area of purchasing and inventory control. In a hospital pharmacy department,

for example, Federal statutes require a daily update of the supply of narcotics and other dangerous drugs. A pharmacy which was cited in the ECHO report was experiencing stock losses and lost charges of $66,000 a month until point of origin data collection was instituted.[59]

The purchasing function may be incorporated into an inventory control system quite easily. When a stock item reaches a preestablished minimum, an amount could be reordered to raise the inventory level to a preestablished maximum. More sophisticated systems could account for changes in price schedules or delivery schedules.

There did not appear to be a large need for an automatic inventory control system in the hospitals surveyed, however. One materials manager commented: "When you need a computer to control your inventory, you've got too large an inventory!"

More and more equipment is becoming available to automate various functions of the clinical laboratory. When a blood sample is analyzed in the clinical labs using a SMACK® machine, for example, the results can be entered directly into a local data base. After a human operator confirms that the results are reasonable, they could be transferred to the central data base where the patient record is maintained. The results of the blood test would then be available immediately at the nursing station, doctor's office, and pharmacy. While accurate statistics are unavailable, the department heads interviewed by PSSC estimated that the average delay from the time a physician ordered a lab test until the patient's record was updated was 12 to 24 hours. STAT tests were available in 30 minutes to an hour.

A medical information system probably would not improve the performance of STAT tests (the results generally are now conveyed immediately by telephone), but would reduce the average delay significantly. Clinical lab technicians would be free to concentrate on analyzing fluid and tissue samples, not answering the telephone. A pathologist interviewed by PSSC observed: "90% of the medical staff in my hospital want to know the results of 90% of the tests they ordered on the previous day between 7:30 a.m. and 10:30 a.m."

The principal motivation today to install a medical information system is to reduce the incidence of lost charges and reduce the "float." A patient's account is allowed to age three to five days after discharge in most hospitals to permit collection of late charges. The average patient, although very grateful to the hospital on the day of discharge, generally won't make a down payment on services rendered until presented with a final billing statement, which the average hospital cannot provide.

A measure of the size of the "float" is the number of days of average daily revenue that are tied up in accounts receivable. The average figure for the hospitals in the system surveyed by PSSC was 61 days in November, 1978. A 400-bed hospital has average daily revenues of approximately $100,000. Thus, each day of reduction in accounts receivables frees $100,000 of capital.

The Humana Corporation of Louisville, Kentucky is establishing a centralized accounts receivable system for its 60 hospitals. Humana expects to reduce the number of human interfaces which must be maintained to gain reimbursement from all of the third party payment agencies with which it does business from 3,548 to 146.[60] Humana expects to reduce its average days of revenue in accounts receivable from 55 days to 14 days in the process.[61]

Improved external communications could make several contributions to financial management. First, it could reduce the float by establishing an on-line system for determining eligibility for coverage and the appropriateness of a billing statement. Second, it will facilitate intermin billing.* Third, it will permit hospitals to prepare a final billing statement and present it to the patient on the day of discharge.** Fourth, it will facilitate use of Electronic Funds Transfer systems.

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* Hospitals are obliged to bill the Health Care Financing Administration when the account of a Medicare inpatient exceeds $10,000. At its discretion, a hospital may submit "interim" billing statements to third party payment agencies when an account exceeds a lower, preestablished amount, say $2,000. The practice of interim billing reduces the float at the expense of increased administrative costs.

** The Business Office usually has 24 hours advance notice of an impending discharge.

And finally, it will facilitate construction of central bases of financial records to give top management more timely, accurate information about each hospital in the system.

D. Multiphasic Health Testing: Consumer Awareness of Treatment Options

Multiphasic Health Testing Service (MHTS) is a controversial element of health care which has been developed extensively by Kaiser Permanente in the last 25 years. Treatment of the "well" and "worried well" has been the traditional domain of the private physician, and several administrators whom PSSC interviewed expressed reluctance to offer MHTS for this reason. They did not question its cost effectiveness.

An institutionally based MHTS could be used routinely to perform inpatient and outpatient examinations. It could be accessed by physicians and nurse practitioners to perform physicals in their offices or in schools or businesses.

An interesting adjunct to the traditional form of a MHTS was suggested in one of the discovery sessions. The consumer could be informed of his health status and, if appropriate, his treatment options. Different hospitals might have different average prices, length of stay, morbidity rates, and mortality rates for the same ailment. An independent MHTS might be attractive to the consumer because of its objectivity in describing treatment options.

MHTS often is criticized for its tendency to produce "false positives." In a survey of over 30,000 examinations at Kaiser, 35% of the patients who were referred to a physician by the MHTS had no significant abnormality.[62]

A much more serious problem for a MHTS is a "false negative," which results when a sick patient is given a clean bill of health. That patient might later become very sick and even die, and the testing service might be sued for malpractice. No MHTS service is immune from this problem. Practically speaking, the community must establish a level of "false negatives," say 2%, which it considers to be acceptable. The MHTS would

then be designed to minimize the probability of a "false positive" (the well patient who nonetheless was advised to seek follow-up treatment), subject to the 2% constraint on the level of "false negatives." If the community were to insist that "false negatives" be kept below 1%, the percentage of "false positives" would rise, as would the cost of health care. The community must understand that it is impossible to eliminate totally the occurrence of "false negatives," unless we all establish permanent residence in hospitals.

Dr. Morris Collen of Kaiser Permanente devoted a chapter of his book to an evaluation of the effectiveness of MHTS. His summary statement is eloquent and relevant to the broader issue of the efficacy of computers and telecommunications in health care generally.[63]

"Since MHTS is still an evolving component of health care delivery, its objectives are still developing and its applications are becoming more diversified....However, as of 1977, the extent to which MHTS has achieved its objectives can be summarized as follows:

From the viewpoint of the patient, MHTS:

(1) Decreases waiting time for appointments for health checkups and/or for entry to a health care system (especially if the physical examination is provided by nurse practitioners) by eliminating the constraint of the traditional physician first visit.

(2) Greatly decreases the length of time necessary to complete a health checkup.

(3) Is significantly less costly.

(4) Is very acceptable, achieving a high level of patient satisfaction.

(5) Effectively d tects disease before symptoms appear, evaluates the patient's health status, and appropriately refers him for follow-up care for any abnormalities found.

(6) Improves long-term outcome by decreasing mortality of potentially postponable conditions, and for middle-aged men decreases days lost due to disability, thereby increasing net earnings.

From the viewpoint of the physician, MHTS:
(1) Serves as a referral center for his patients for good quality health status evaluation at a low cost.
(2) Effectively detects previously unknown disease and monitors status of known disease, thereby identifying those who need further diagnostic study.
(3) Improves quality and personalization of health checkups by providing: (a) normal values individualized for each patient by age, sex, etc., (b) comparisons with prior test results for trend comparisons, and (c) greater accuracy by use of automated equipment and better quality control.
(4) Saves physician time by transferring many routine repetitive tasks to allied health personnel and automated instruments.
(5) Can improve the data base available to physicians, thereby decreasing the amount of time spent in routine data gathering for diagnosis and allowing more time with the patient for therapy.
(6) Provides a comprehensive health profile of patients in a uniformly formatted record.
(7) Stores data in computerized files for subsequent clinical, epidemiological, and health services research....
From the viewpoint of the health care systems planner, MHTS:
(1) Is effective and efficient for early disease detection, health surveillance, and disease monitoring.
(2) Provides the most efficient method of furnishing health examinations to a large population....
(3) Can provide health education and counseling so as to increase patient compliance with referrals to health maintenance organizations."

E. Video Teleconferencing for Administrative Coordination

The executive directors and department heads of the hospitals surveyed meet frequently to coordinate policy and establish guidelines for group

purchasing. The use of video telecommunications in lieu of travel could reduce costs and make it possible for these dispersed executives to meet more frequently if necessary. It would also become more practical for specialists, such as lawyers and physicians, to make brief appearances at meetings to discuss matters which concern them, thereby enabling multi-unit hospital systems to reach closure more quickly on many policy issues.

On the average, executives from each of the four hospitals surveyed by PSSC are involved in 12 off-premises meetings a month with their counterparts at the other hospitals in the system and/or with the management services firm that all of the hospitals use. Each of these meetings, when travel time is included, consumes an eight-hour day. The time of these executives has an average value of approximately $250 an hour to their hospitals. The individuals interviewed by PSSC felt that 70% of these meetings could be conducted using suitable video teleconferencing facilities. The monthly value of teleconferencing for these meetings is thus approximately (12)(0.7)(8)($250) = $16,800, where the cost of transportation, food, and lodging is ignored.

A main objective of these meetings is to agree on standards for group purchasing. The multi-hospital system achieves about a 33% discount over the price individual hospitals pay as a result of its group buying. It now takes about 11 weeks for the material managers to reach consensus on large items. One materials manager informed PSSC that with suitable teleconferencing facilities, which would allow physicians having strong opinions on standards to become directly involved in the group deliberations, the time required to set standards could be reduced to about three weeks.

The price paid by an individual hospital for the present delay in reaching consensus can be measured conservatively by examining the cost to a hospital of losing its discount for a period of time after a contract expires. This happens about 10% of the time. Loss of the 33% discount on 10% of its group purchasing volume amounts to about $74,250 annually per hospital. By reducing the procurement delay from 11 weeks to three weeks,

a savings of approximately (8/11)($74,250) = $54,000 could be realized annually by the average hospital.

The chief engineer of a hospital estimated that the staff was greatly disappointed in its choice of major capital equipment purchases about 10% of the time. He estimated that in two-thirds of these cases, either a better selection could be made or the complainers would feel better if they could become involved in the selection process. Video teleconferencing with other hospitals who owned the item under consideration or with potential equipment suppliers would be satisfactory. For a 170-bed hospital, which buys about $800,000 of such equipment annually, the savings would be approximately (2/3)(0.1)($800,000) = $53,000. For a 400-bed hospital, the savings would be about $133,000.

The average value of video teleconferencing facilities to the hospitals surveyed is about $350,000 annually. This estimate is conservative and does not take into account the clinical value of a teleconferencing facility. The ability to send and receive high-resolution imagery would be valuable in the radiology and pathology departments, for example.

F. Workload Smoothing Among Multiple Hospitals

Personnel and equipment needs in many hospital departments are sensitive to the patient census and caseload mix. When there is data entry at the point of origin of most data regarding the status of each patient, under certain circumstances portions of this data could be accessed in real time by other institutions which could provide assistance during periods of peak loading or unforeseen staff or equipment shortages.

Workload smoothing perhaps will be easiest to accomplish in certain administrative areas. Transcription service, for example, easily could be provided by one hospital for another. Support for the accounts receivable, accounts payable, or billing functions could be provided if the supporting hospital had access to the necessary data bases and standard formats for the data were being used.

Personnel could be transferred temporarily from one hospital to another provided the distances were not excessive and the operational procedures were similar. Better scheduling algorithms would be helpful in establishing the correct mix of temporary employees. A director of nursing informed PSSC: "Scheduling is the most important function of a nursing administrator and the area where they tend to be weakest."

Point of origin data collection already is used in the coronary care and intensive care units of hospitals. The patient's vital signs are monitored at central nursing stations. This concept could be extended from one hospital to another, given proper communications support.

The high reliability of solid-state equipment and the low cost of microprocessors is making it uneconomical to perform periodic maintenance. A microprocessor can be programmed to monitor a piece of expensive equipment, such as a Volkswagen or an EKG machine, to verify whether or not it is performing within specified limits. These microprocessors also could perform process-control functions. They would be interrogated periodically by a minicomputer operated by the hospital. When a given piece of equipment no longer is operating within specified limits, the chief engineer would be notified and, in some cases, the supplier or an outside maintenance contractor would be called for assistance.

Use of telemetry would permit aggregation of spare parts and trained technicians. Hospitals would benefit both in terms of cost and quality -- provided the equipment which is to be maintained in this way doesn't break down too often.

An approximate measure of the value of this form of maintenance can be calculated as follows: In a 170-bed hospital, a piece of valuable equipment breaks down about once a week. This equipment generates approximately $375 a day of revenue to the hospital, of which only 20% is recoverable when there is an outage. The mean time to repair today is about three days. Thus, the annual cost to the hospital of such breakdowns is approximately (52)($375)(0.8)(3) = $46,800. Use of microprocessors

and telemetry to provide more advanced warning of possible failures and better diagnostics to know what spare parts should be shipped to the site to effect repair could reduce this loss by about 50%, resulting in an annual savings of $23,400. The savings in a 400-bed hospital would be approximately $55,000.

G. Educational Support Services

The need to contain costs, increase productivity, and improve efficiency is creating increased demand for education and training at all levels within the hospital. While there is no consensus on an overall solution to the cost containment problem, some elements of the answer do seem clear. Hospitals should reduce the patient's length of stay, increase emphasis on ambulatory care, and in general begin focusing more on preventive medicine and less on curative medicine. It follows, therefore, that hospitals must do a better job training patients to care for themselves. As the length of stay declines, so must patient responsibility for his own care increase.

We live in an age of the informed consumer. How can hospitals attend to their traditional role of curing the sick while meeting their growing obligation to the community to assist in the prevention of disease? If a hospital is to survive the current economic squeeze, it must begin to redefine its role -- both within the community and within the health-care industry. Past experience suggests that most hospitals will manage this transition successfully.

Telecommunications may be of help. The Greater Cleveland Hospital Association has responded to the challenge in a novel fashion. Since January, 1978, it has been distributing audio-visual materials in real time to 18 Cleveland hospitals using an Instructional Television Fixed Service (ITFS) system to interconnect participating hospitals with the program source. Hospitals receive eight hours per day of programming which is distributed by closed circuit TV to the patient's room seven days a week. It costs the hospital $0.08 per patient per day to subscribe

to this service. Participating hospitals generally include this charge in the room fee and are receiving partial reimbursement from Blue Cross. The Greater Cleveland Hospital Association is attempting to obtain reimbursement from other third party payment agencies.

The Greater Cleveland Hospital Association is working with PSSC, the American Hospital Association, and the Hospital Television Network to extend this service nationally. Through a combination of existing cable TV systems, existing ITFS systems, and new satellite earth stations, PSSC expects that over 1,000 hospitals will be able to receive the program by January, 1980.

The satellite networks of RCA Americom and Western Union will be used to provide national distribution. PSSC estimates that the cost per subscribing hospital for this national service should be comparable to that now paid by Cleveland hospitals.

Professional societies, medical schools, and other organizations interested in distributing audio-visual materials to hospital-based personnel are also expected to use this distribution system. The potential demand for continuing education by hospital personnel has been documented in a previous PSSC study.[64]

In the next 20 years, on-line medical information systems will provide physicians with medical information and patient data in real time. By incorporating valid findings of medical research into the computer programs, medical information systems will facilitate the spread of new medical knowledge during the actual practice of patient care.

H. Assessment of the Quality and Utilization of Medical Care Services

Medical information systems can be programmed to assess the quality of medical services provided against agreed upon standards for acceptable care. Professional Standards Review Organizations (PSROs) were mandated by amendments to the Social Security Act in 1972 to review the quality and utilization of medical services provided in Medicare, Medicaid, and maternal and child health patients. These legally mandated functions could be accomplished without the expense of additional data collection. Improved

information processing would enable PSROs to inform hospitals and physicians in a more timely fashion when certain treatment procedures are inappropriate. The physician could be notified, for example, when a patient's length of stay exceeds Medicare guidelines for the particular admission diagnosis. Either the diagnosis would be changed, the patient would be released, or it would be clear to the physician and hospital that Medicare would not provide compensation beyond that point.

CHAPTER VI

DESIRED ATTRIBUTES OF A HEALTH INFORMATION NETWORK

New developments in communications and data processing are creating policy issues which impact on the structure of the health care industry. These technologies show promise of enhancing productivity while at the same time improving the quality of health care.

There is a price, of course. Health care providers will have to relinquish some of their independence and autonomy to gain the benefits that central data bases and communications networks could provide.

Although it is difficult at this time to foresee clearly the impact of continued development of communications and computer technology on the structure of the hospital industry, one thing is certain: the more modest the required institutional adjustments, the more likely is early acceptance. With this thought in mind, PSSC suggests 11 desirable network attributes, which are not entirely consistent with one another, as tentative design goals for the further development of health information networks: (1) wide system connectivity; (2) integrated functions; (3) good security; (4) reliability; (5) flexibility; (6) capable of modular growth; (7) autonomous operation; (8) integrity of data bases; (9) uniform system standards; (10) data bases easily shared; and (11) productivity enhancing.

The findings of this chapter are somewhat speculative. They are based on PSSC's intuitive inferences regarding the network implications of the service requirements uncovered during this preliminary survey. There are underlying technical and policy conflicts that probably will not be resolved until the hospital industry acquires more working experience with advanced communications systems. To repeat, the desired attributes should be regarded as tentative design goals.

CHAPTER VI

Implicit throughout the discussion of this chapter is the need for conscious, interinstitutional planning to translate the potential of communications and computer technology into realistic operational systems. Ideally, there should be one management agent with the resources and trust relationships to represent adequately the diverse interests of the health care industry. Failing that, there should be a small number of management agents who are capable of aggregating the requirements of different elements of the industry. Perhaps a certain amount of competition between management agents will stimulate innovation and insure fair prices.

A. Wide System Connectivity

Almost half (47%) of the 7,099 hospitals in the U.S. have fewer than 100 beds. It is these institutions that could benefit most from improved access to specialists and clinical support services, educational services, and administrative support services. The networks should include hospitals, physicians, medical schools, equipment suppliers, service vendors, third party payment agencies, PSROs, professional societies, and regulatory bodies.

This requirement could be met if communications were provided by a public network, such as AT&T's Advanced Communications Service. It will be more difficult for one or more non-Bell carriers to provide the necessary connectivity. There appears to be a need for industry cooperatives to aggregate requirements and become the legal customer for the network services that are provided by one or more common carriers. Few hospital systems could afford their own private communications network, yet all hospitals will be interested in convenient, low-cost access to central data bases of medical knowledge.

A precedent for such cooperatives was established by the air transportation industry in 1929. Aeronautical Radio, Inc. (ARINC) manages the Private Line Intercity Network that interconnects airports in the United States and supports such functions as the airline reservation

services. ARINC also manages that portion of the radio frequency spectrum which has been allocated by the Federal Communications Commission to support requirements for air-to-ground communications.

B. Integrated Functions

Ideally, a health network should support all of the applications discussed in this report plus other, perhaps more important, applications that will be discovered in the future. Nonetheless, the implied design criteria are not as nebulous as one might think. The telecommunications system should support requirements for voice, data, facsimile, and video. The data processing system should be flexible, reliable, adaptable to many different hospital environments, and capable of modular expansion.

Fortunately, communications and computer technology are converging to a digital format.[14] Both Western Union's Advanced Westar system and the SBS system, for example, will be able to allocate the capacity of the network dynamically to support changing requirements for voice, data, facsimile, and/or video.[65, 66]

The communications environment of the early 1980s, which is designed in part to improve the productivity of the office, will support the foreseeable requirements of the health care industry. Whether the average health care provider will be able to afford these advanced services, however, remains to be seen. PSSC is confident that suppliers will offer the necessary services at affordable prices once the hospital industry aggregates its requirements.

C. Security

A health care information network should facilitate transfer of highly sensitive patient records, administrative data, quality assurance records, and financial information. The establishment of adequate security and control procedures for transferring sensitive data in a multiple hospital system environment will tax the capabilities of the communications and data processing industries beyond their present limits.

Much useful work has been accomplished already. AT&T, GTE, Western Union, RCA Americom, Amsat, and Satellite Business Systems are designing

private networks for large corporations and government agencies to meet exacting security standards. These networks by definition, however, will be managed and controlled by a single entity which already has established authority over the operation. The banking industry has been making steady progress developing cost effective Electronic Funds Transfer Systems, some of which utilize distributed data processing techniques. Again, however, control over the network always rests with a single entity, which has clear authority to establish and maintain necessary security measures.

The health care industry is highly decentralized, and most Americans would strongly prefer that it remain this way. Further R&D activity is required to understand these security and control problems, which will be difficult to solve. While the security of the data bases will never be perfect, it could be better than that now maintained by most hospitals.

It will be necessary to establish a consensus within the health care community (which is supported by the general public) regarding standards of privacy. The Privacy Protection Study Commission, which issued its final report in 1978, has made substantial progress; but there remain undercurrents of dissent.[67, 68] The degree of consensus is impossible to judge at this time, and should be explored in a follow-on study.

There are technical issues which must be resolved to achieve adequate privacy.[69] Top management of a hospital system should be capable of examining and verifying the accuracy of any randomly selected transaction which occurred in their system at any time or point in the history of that transaction. Also, it should be impossible for top management of a competing hospital system to perform such an audit -- even though they are part of the same network and have access to many of the same data bases. The manager of the health information network must be able to define and implement the necessary software and procedural tools to insure that all transactions in the network, regardless of their point of origin, possess an audit trail history and are ultimately identifiable

in terms of legally admissable physical documents, where necessary. According to Wess:[70]

> *"Auditing software is just becoming sophisticated enough to allow examination of data base records and audit trails (in a single facility). No such distributed auditing tools are currently available."*

The above capability, in addition to enhancing network security, would facilitate reconstruction of data bases in the event of unforeseen alteration or destruction, accidental or otherwise. It would also enhance network access and authentication control.

D. Reliability

As hospitals begin to rely more upon communications and data processing, they will begin to demand higher reliability from the support systems. One can obtain more reliability by adding redundancy to the system. Eventually, there comes a point of diminishing marginal returns. The reliability of the public telephone network, for example, is in excess of 99.99%. One might elect to accept a lower level of reliability in a private network for which one must make capital investments in equipment, however. These same statements apply to the reliability of the data processing equipment or of the data bases.

Those who want additional reliability should be able to obtain it -- provided they are willing to pay the price. Unfortunately, the whole group could be affected adversely by the needs of one user.

The core network must be designed to accommodate the most stringent reliability requirements of the system: A chain is as strong as its weakest link. A small number of hospitals which had extreme reliability requirements could appreciably drive up the price for all users. Thus, there will be a need for the participating hospitals to agree on a process whereby they can determine when the point of diminishing marginal returns is reached for the backbone system.

E. Flexibility

Medical information systems have been criticized for their lack of flexibility. Past systems were developed at great expense and debugged at one hospital facility, but they sometimes were not responsive to the requirements of other hospitals. This problem is serious. On one hand, the supplier must develop standard product lines to bring the price down; and on the other hand, no two hospitals are alike. Apparently their differences are more significant than certain data processing suppliers once assumed.

The situation is improving on at least two fronts: More and more hospital employees are being introduced to data processing while they are in school and are no longer as intimidated by computers as was once the case. Second, suppliers are learning from past experience that they must build flexibility into their medical information systems to be successful. New systems are being developed so that they may be "fine tuned" by the user on site. The software is being written in higher-level languages which allow relatively unsophisticated users to program the necessary modifications.

It would be wrong to imply that the "flexibility problem" has been solved, however. PSSC's impression, from having conducted 92 interviews in five hospitals, is that the really significant activities in a hospital that involve direct patient care have been relatively unaffected by advances in data processing. Suppliers will have much more difficulty designing acceptable support systems in the clinical area of the hospital. The familiar reaction of the new user to data processing ("the computer screwed up again!") could lead to malpractice suits in the future. Hence, suppliers are wary of entering the clinical area, where the payoffs -- and liabilities -- could be highest. There is a need for continued R&D to improve medical information systems in non-financial areas.

F. Possibility of Modular Growth

During the 1970s, the technology of comprehensive "results reporting" medical information systems reached maturity.[31, 32] Nonetheless, the rate of diffusion of this technology has been slow.* Hospitals tend to be wary of "all or nothing" attacks on their information processing requirements. Too often in the past actual performance has fallen well short of expectations.

Ideally, the medical information system should be capable of modular growth. Subscribing hospitals should be free to decide which applications they choose to use initially and when they choose to add new applications to their menu of services. The interface standards should be such that a hospital is not locked in to a particular supplier when he makes a commitment to a medical information system.

Unfortunately, by opting initially for departmentalized information systems, the hospital may foreclose the option of later consolidation of higher level planning and control functions. The political and financial climate of the average hospital tends to favor implementation of dedicated systems designed to serve the needs of individual departments, such as the Business Office, Intensive Care Unit, Clinical Labs, Pharmacy, or Radiology. (See Chapter II.) The hospital administrator who favors implementation of an interdepartmental medical information system must overcome several barriers. For one thing, such systems are more expensive; and even if sufficient capital is available, the required lead times can be burdensome. One must obtain approval from the different hospital departments and generate a certificate of need statement for the Health Services Agency. A time consuming educational effort usually is required to train the staff to properly utilize an advanced medical information system. And any change in the established routine can be threatening to certain people.

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*"Results reporting" systems permit participating departments to both store and retrieve information from central data bases. "Order entry" systems are used only for data entry by most departments -- generally to help the Business Office reduce the incidence of lost charges and the days of revenue in accounts receivable.

These two factors, high cost and an unfavorable political climate, are major reasons why the rate of diffusion of "results reporting" systems has been relatively low. Until the benefits of this technology become compelling, its rate of acceptance is likely to remain slow.

G. Autonomy

Hospitals prefer to function as autonomous units, and suppliers of data processing and communications services would be well advised to respect this autonomy. The decision on what features and what performance should be provided by the medical information system should be made by the client hospital. If this hospital is willing to pay the price for a nonstandard set of applications or nonstandard hardware or software, that should be its prerogative.

Such an approach is possible if the hardware interfaces and network protocols and data base interfaces are defined by appropriate standards. Such standards do not now exist.

PSSC has discovered, to its consternation, that public service organizations, as a general rule, have an aversion to sharing. Colleges, religious bodies, law enforcement agencies, secondary schools, government agencies, and hospitals all have a nearly unblemished record of opting for local autonomy over central authority when presented with a realistic choice. If it is necessary for the supplier to gain consent from two or more hospitals (or hospital systems in the case of corporately owned units) before making a capital investment, the likelihood of implementing an operational system is reduced appreciably. At the very least, the time required to reach closure is increased.

The agent of change must overcome a "flock tending" problem. Just when success seems within reach, there is usually someone who sees an opportunity to preserve his autonomy at the expense of the group. This problem can be overcome with time, money, and patience -- if trust can be maintained.

H. Integrity of Data Bases

A major reason for creating central data bases is to gain control over information of value to an organization. The technology is maturing to a point where it soon should be possible to maintain consistency automatically between items of "identical" data in a distributed network. A health information network will tax the state-of-the-art, however. Many hospitals would elect to maintain local data bases to reflect the state of medical knowledge as practiced in their community. Probably they would encourage their own staff to contribute to this body of knowledge. Perhaps there will be an explosion of new medical knowledge, fueled by beehives of activity in many different areas. Who is to decide when and by whom the local, regional, national, or international data bases of medical knowledge should be updated?

The medical community must agree upon a process whereby all organizations or individuals are encouraged to contribute to network data bases of medical knowledge. What should be the responsibility of the National Library of Medicine in this process? What about the American College of Physicians? The county chapter of the American Medical Association? Dr. Christian Barnard? Who will adjudicate local disputes? Regional disputes? International disputes? What procedure should be followed to implement the recommended procedures? Will the administrative machinery to implement this process be available to guide development of the technology, or will the structural changes be technology driven?

I. Sharing of Data Bases

When there are two or more locations of the "same" data base, it is important that some central authority know where these data bases are. When there are valid reasons to change elements of these data bases, the central authority should have some systematic means of accomplishing this task, or at least of informing the user of the fact that a recognized authority deems it advisable to "update" this data base.

Similarly, a user who discovers a need for a new data base may prefer not to re-invent the wheel. He should be able to ask a central authority whether the desired data base exists and, if so, the procedures which should be followed to gain access.

A user may wish to duplicate a data base. A procedure must be established to compensate the authors of this information, if appropriate.[71]

Should a user decide to create a new data base, there should be standards which he could follow to facilitate access by other users of the network.

J. Standards

There is a need to define standards for such items as the patient's medical record, third party invoices, the elements of other important data bases, the protocols to access the network, the interfaces between the elements of a distributed data base, the elements of communications and computer hardware, the level of reliability of individual elements of the system, and security measures to protect the system. There is a need to develop standards for data base integrity. There is a need to define standards of medical care so that software developed in one community can be applied in another. There is a need, for example, to define what level of "false negatives" for a particular multiphasic health testing service constitutes acceptable medical practice for the particular ailment under consideration. Standards must be developed regarding what organizations are eligible to join the network and at what level of access. Standards must be developed regarding actions that should be taken against users who violate certain standards.

The Federal government, which is the major financier of the health care industry, is in a position to play a decisive role in the determination and implementation of necessary standards. There is a need, of course, for voluntary compliance. Broad industry consensus behind whatever standards are developed is probably indispensable.

K. Productivity Enhancing

One implication of the drive to contain health care costs is that new medical technology is not necessarily justified simply because it improves the quality of care. It should also be cost effective.

Unfortunately, cost effectiveness is difficult to prove in the case of developing technology. It is still not clear to what extent medical information systems will be cost effective in patient care. Distributed data processing shows great promise, but the final verdict is unclear.

A number of factors that are beyond the control of technologists will play a part in determining whether or not MIS technology is used in a manner which could enhance productivity. The structure and incentive system of the health care industry is so complicated that it may be advisable for industry and government to jointly subsidize realistic demonstrations of health information networks to focus more clearly on their cost containment implications. Perhaps hospitals in the Veterans Administration system and/or the health care system operated by the Department of Defense could serve as test beds.

Until MIS technology has proven ability to enhance productivity, particularly in clinical applications, hospitals will be reluctant to make additional capital investments of their own. The National Center for Health Services Research or other appropriate federal agencies should pick up where they left off in the mid 1970s until the economic case is clear. The network implications of MIS technology should be investigated in parallel. The need is greatest in smaller hospitals, which will be the last to be able to afford comprehensive MIS systems in the absence of federal incentives.

L. Need for a Network Manager

The hospital industry should consider creation of an organization to oversee development of communications and data processing in health care. Should the industry be unwilling or unable to place responsibility

in a single management agent, the technology will continue to advance, but it will take longer for the hospital industry to reap the potential benefits. In fact, it is conceivable, as the Office of Technology Assessment has suggested, that the potential benefits in the areas of direct patient care, planning, and research are beyond reach in the absence of active involvement by the Federal government or some other management agent.[72]

There are precedents for the hospital industry to follow as it considers its options in forming a management entity. The air transportation industry created ARINC in 1929. The American Stock Exchange created what is now known as the Securities Industry Automation Corporation in 1972. The banking industry is considering formation of an industry communications cooperative at this time.

The basic functions of the Network Manager include defining the requirements of the network, establishing necessary standards, raising the necessary capital, managing the procurement, assisting member institutions with requirements studies and procurements as needed, marketing the network services, and administering the network. Under the latter category are such functions as data base management, maintenance of network security, administration of "override" activities during periods of momentary outage in portions of the network, interfacing with those organizations which are responsibile for keeping certain data bases current, and billing existing customers. The network could be managed either by a for profit or non profit entity.

No existing organization now has all of the necessary attributes to function effectively as Network Manager. Many organizations probably will be interested in this role and, given strong backing, could become effective. Candidates include the National Library of Medicine, the Committee on Professional Hospital Activities, the American Medical Association, and the American Hospital Association.

It will be difficult for the health care industry to arrive at a consensus. As John Witherspoon, former president of PSSC observed, "God created the universe in seven days, but He had the unique advantage of starting from scratch."

CHAPTER VII

CONCLUSION

A. Barriers to Implementation

There are at least five barriers to the further development and eventual widespread implementation of medical information systems and health information networks:

1. Lack of consensus regarding a solution to the cost containment problem;
2. Lack of leadership from within the Federal health care establishment in support of a significant R&D commitment to medical information systems and health information networks;
3. Lack of standards;
4. Lack of safeguards to insure privacy of sensitive data bases in a distributed hospital environment; and
5. Lack of capital within the health care industry, particularly at rural and inner city institutions which most need improved access to health care support, to invest in communications and data processing systems.

The general trend today toward consolidation of institutional providers will facilitate implementation of medical information systems -- if and when they are demonstrably cost effective.

There is a lack of leadership within the Federal health care establishment in support of a significant R&D commitment to medical information systems. It is not clear at this time whether this absence of support reflects ignorance on the part of top policy makers or benign neglect.

Development of medical information systems may be characterized by high costs and long lead times. A 1975 survey of ambulatory care sites

having such systems reported developmental costs ranging from $100,000 to $10 million.[73] The principal Federal agency charged with developing medical information systems is the National Center for Health Services Research (NCHSR) which spent a total of $31 million on such projects in the period between 1969 and 1978. Support from this source has been gradually diminishing from a peak level of $4.6 million in 1974. Unfortunately, NCHSR may have fallen into the same trap as many of the hospitals surveyed in the ECHO report. (See Chapter II.) Funds were withdrawn during the critical Stage II developmental period at precisely the time when more funds were needed, hastening failure of the data processing initiatives under development.

The private sector is emphasizing financial applications of MIS technology. The clinical areas, where the payoff may be highest, are being neglected.[26] Also, there is no R&D support at present for developing the networking capabilities of MIS technology. It is not clear at this time, for example, how to design distributed data processing systems which offer the high level of security required to provide the necessary confidentiality of data bases in a distributed hospital environment. The fact that the hospital industry is highly decentralized is a difficult technical and administrative complication. Further R&D activity is required to understand and solve these security and control problems.

The Department of Defense and NASA routinely contract with private industry to develop necessary technology, but the National Center for Health Services Research currently does not have such authority.[74]

There is a lack of industry-wide standards regarding the format for the elements of necessary data bases (such as a patient record or a third party invoice), protocols to access the network, hardware and software interface specifications, and appropriate security procedures. The definition of acceptable standards will require R&D expenditures and the formation of an industry consensus.

The bottom line today is cost containment; and the verdict is still out on MIS technology, particularly insofar as clinical applications are concerned. Because of past failures by hospitals to utilize data processing technology effectively, they are likely to insist on a more cautious, modular approach in the future. There is a need for continued R&D to establish whether or not clinical applications of MIS technology are cost effective.

It will be difficult for hospitals to accumulate sufficient capital to implement a comprehensive health information network. If it is necessary for individual hospitals to make large capital investments in data processing and communications apparatus, the rate of adoption will be slow. It is likely to be extremely slow if it is necessary to obtain a group consensus on a shared capital investment before proceeding with implementation. The most promising approach would be to allow individual hospitals to lease the desired products and services on an autonomous basis. This approach could be followed if one or more private entrepreneurs were willing to assume the risk of financing the backbone system. Alternatively, the hospital industry could form communications cooperatives to facilitate creation of standards, capital formation, design and procurement of the backbone network, and administration of the system.

B. Recommendations

The Office of Technology Assessment of the U.S. Congress completed a study in November, 1977, entitled Policy Implications of Medical Information Systems.[75] The policy alternatives raised in this report bear repeating:

> *"Without a Federal policy toward these systems, their diffusion may well proceed indiscriminately and standardization will not be possible. If so, the full potential of medical information systems is not likely to be achieved....Because capabilities to improve and monitor the quality of medical care and to facilitate research and planning are the least developed and require standardization, these*

potential benefits might be lost....If Federal action influencing development, standardization, and eventual use of medical information systems is considered appropriate, a range of policy alternatives could be pursued....

- *Provide funding for evaluation of medical information systems in a number of different medical care facilities and locations to determine their effectiveness in terms of relative benefits and costs.*
- *Ensure the availability of medical information systems with specified capabilities and applications by contracting for their design and development.*
- *Provide incentives for medical care facilities to adopt medical information systems that improve the quality of patient care and support research and planning.*
- *Authorize a central organization to develop, validate, and maintain the content of medical knowledge within medical information systems.*
- *Develop standardized medical data bases, including nomenclature, terms, definitions, classifications, and codes for use in medical information systems.*
- *Establish guidelines for precise standards to protect confidi-dentiality of patient data within an institution and release of identified data to third parties."*

The Office of Technology Assessment focused on the development of full capability medical information systems for a single hospital, which is an important step in the establishment of cost-effective health information networks. PSSC recommends that the network implications be developed explicitly in a coordinated R&D program involving government and industry. One means of facilitating this process would be to build a demonstration network for continued R&D activity using government owned

hospitals such as elements of the Veterans Administration or Armed Forces Hospital Systems. Such a demonstration model could validate promising concepts and provide an initial backbone for an operational system.*

A coordinated Federal and private industry investment program in support of wideband hospital communications networks could impact favorably on the three major issues in health care: cost containment, improved access to service, and maintenance of quality. At the same time, it has the potential of opening international markets to the U.S. health industry. The technology is not now mature, but it probably will be by 1990. There are serious problems to be overcome, but the possible payoff may justify significant R&D commitments.

Finally, the hospital industry should consider formation of a communications cooperative to oversee development of health information networks.

The findings and recommendations of this report are based on a detailed study of five hospitals and one management services firm out of a U.S. population of 7,099 hospitals. They should be validated by a survey of a larger cross section of the health care industry.

C. Final Comments

The present emphasis on cost containment is creating a more favorable climate for acceptance of effective medical information systems. Should the Federal government elect to utilize prospective reimbursement formulas for Medicare patients, it will create further incentives for health care providers to consolidate services and place a higher premium on effective management and planning.

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*A recent report issued by the Government Operations Committee, under the direction of Congressman Jack Brooks (D), Texas, is highly critical of the Tri-Service Medical Information System (TRIMIS) program, which is the largest government-sponsored MIS project.[76] The report asserts: *"After a lapse of five years and the expenditure or obligation of $70 million, there is almost nothing to show for the money or effort."* Nevertheless, Congressman Brooks states in his cover letter to Secretary of Defense Brown: *"The TRIMIS concept, under which essential medical services of military medical facilities will be automated, continues to offer the promise of improving the quality of health care while reducing costs."*

A partnership between the Federal government and private industry in a coordinated effort to overcome present barriers to acceptance would offer many benefits. The economic benefits of medical information systems must become compelling before a majority of hospital administrators are likely to implement these controversial machines. Further R&D appears to be necessary.

J. C. R. Licklider in his 1965 classic Libraries of the Future sensed clearly the complex of factors which would dictate the pace of development of information retrieval systems through the year 2000.[77]

> *"Very great and pertinent advances doubtless can be made during the remainder of this century, both in information technology and in the way man uses it. Whether very great and pertinent advances will be made, however, depends strongly on how societies and nations set their goals. Moreover, the "system" of man's development and use of knowledge is regenerative. If a strong effort is made to improve that system, then the early results will facilitate subsequent phases of the effort, and so on, progressively, in an exponential crescendo. On the other hand, if intellectual processes and their technological bases are neglected, then goals that could have been achieved will remain remote, and proponents of their achievement will find it difficult to disprove charges of irresponsibility and autism."*

APPENDIX A

INTERVIEW GUIDE

INTERVIEW GUIDELINES

Prerequisite to Interview -- Review any documented statement of mission, responsibility, or objectives for the organizational unit in which the person being interviewed resides. Review communications applications likely to be of greatest interest to interviewee and prepare lines of inquiry to assess the value of these applications.

The interview questions are sequenced to lead from a general understanding of business activity/objectives to the identification of potential new applications/benefits. They should be tailored to the person being interviewed but should not deviate from this format.

PSSC was not interested in detailed requirements during this initial study. Hence, the questions were kept fairly general, designed simply to identify the interviewee's broad communication needs and potential applications. Further investigation of the needs uncovered may lead to improvements in communications methods or procedures that would yield specific benefits to the interviewee or his department. PSSC did not attempt to formulate a business proposal for improved communications or data processing services during this preliminary study.

UNDERSTAND INTERVIEWEE'S AREA OF RESPONSIBILITY

1. Briefly describe your area of responsibility. Understand that from this point onward the questions are addressed to the needs of your department rather than to you as an individual.

2. What are the major business activities or processes in your area of responsibility? Major objectives?

3. What is the relative importance of each of the business activities identified to your performance measurement?

   Choose one:
   - Extremely Important (1)
   - Moderately Important (2)
   - Small Importance (3)
   - Negligible Importance (4)

4. How is the performance of your department measured?

5. How do you measure the performance of your subordinates?

6. What are the major constraints that limit the performance of your department to levels below what you would like to achieve? Are any of these constraints caused by communications constraints between geographically separate locations, (i.e., travel limitations, document transfer limitations, etc.)? By communications, we are talking about voice, data processing, mail, fax, travel, etc.; any of the ways that two geographically separated people in your organization might use to communicate with each other.

UNDERSTAND IMPORTANCE AND ADEQUACY OF COMMUNICATIONS

7. Review questionnaire. (See Appendix B.) Check activity levels and expenditures for travel, mail, voice, data processing, facsimile, and video. Identify activity concentration points.

8. For each of the major business activities identified, how important are effective/timely communications between geographically separated personnel?

   Choose one:
   - Extremely Important (1)
   - Moderately Important (2)
   - Small Importance (3)
   - Negligible Importance (4)

9. What are the major current communications methods used in each business activity where remote communications are considered extremely or moderately important? (From Question 8)

10. Are the capabilities and funding of current communications methods identified (in Question 9) considered adequate or inadequate to achieve the best possible performance in each business activity (i.e., do you think it would be cost effective if current communications funding were increased or the methods available to communicate with others were improved)?

11. In the areas identified as inadequate (in Question 10), what are the limitations or problems with the current methods of communicating?

12. What benefits would you realize if, in those areas identified as inadequate, the limitation could be eliminated or removed or the capabilities improved?

DESCRIBE CAPABILITIES OF ADVANCED TELECOMMUNICATIONS SYSTEMS

13. For interviewer: At this point describe the new communication capabilities being investigated. Review highlights of orientation session attended previously by the interviewee, touching upon:

- Video Teleconferencing
- High Speed, High Quality Document Distribution
- High Speed Data Applications
- Enhanced Voice
- On-site Network Control and Management
- Others, as appropriate, i.e., capacity on demand, integrated voice-data-image, etc.

IDENTIFY POTENTIAL NEW APPLICATIONS AND BENEFITS

14. For the interviewer:

(1) Ask the interviewee which of these new capabilities could help correct any of the limitations/problem areas identified (in Question 11).

(2) From your knowledge of the new communications capabilities and the interviewee's previous responses to questions, what potential uses can you think of? Discuss them with the interviewee.

15. What is the value and capability that must be offered in order to make each application identified (in Questions 12 and 14) useful? If the value is not easily quantified (for example, it is not a displaced cost), how could a reasonable value to the business be established?

16. What major changes do you envision in the next 2-5 years that will impact your area of responsibility or communications requirements? Would any of the new communications capabilities described be more valuable if these changes occur?

17. Where else in the organization do you think these new communication capabilities could yield significant value to the business?

APPENDIX B

PRE-INTERVIEW QUESTIONNAIRE

Public Service Satellite Consortium

MEMORANDUM

TO: Participants in Telecommunications Survey

FROM: Polly R. Rash, PSSC
James G. Potter, PSSC

DATE: January 15, 1979

SUBJECT: Pre-Interview Questionnaire

This questionnaire is part of a test survey being given to selected hospitals in the U.S. by the Public Service Satellite Consortium under a NASA contract. Your time and answers are appreciated and will help guide a more significant follow-up survey. No direct attribution of any data will be made to you or your hospital -- your data will be combined statistically with several other participating hospitals. The results of the test survey will be available to each participant around May 1979.

Please answer the following questions as accurately as you can, and estimate any information which you do not have in your files or records. Please try to give a total answer for your department, avoiding (as much as possible) guesses or describing things as you would like to see them.

You could help make this study more thought provoking and rewarding by taking the time before the interview to consider how your department exchanges information with the outside world. This exchange occurs in one of three ways: through meetings, the mail, or via telecommunications. Telecommunications activity occurs in one of four ways: via voice, data, imagery, or facsimile. Please consider before the meeting what external parties are contacted frequently by your department.

Could you also list before the interview three changes which will impact significantly on the information exchange activities of your department in the next five years? What will stimulate those changes? A need for greater cost control? Demand from the community for new services? An entrepreneurial thrust?

Thank you for your time and help in participating in this survey.

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APPENDIX B

Public Service Satellite Consortium

DEPARTMENT_____

INTERVIEWERS_____

INTERVIEWEE_____

TITLE_____

A. TRAVEL

1. Does your group or department have a specific travel budget? (YES or NO)____

2. What is it? (annually) $_____

3. Estimate (in %) the amounts spent on travel:
   a. Local (within 150 miles) (%)_____
   b. Non-local (more than 150 miles) (%)_____

4. Estimate the amount of your travel budget spent on:
   a. Educational purposes (%)_____
   b. Professional society meetings or business (%)_____
   c. Provision of business services (%)_____
   d. Hospital-related community affairs (%)_____

5. What amount of your group's travel is dedicated to routinely scheduled meetings with a fixed group (for example, for review of financial statements, group purchasing standards, etc.)? (%)_____

6. Are there activities or meetings in which your group should (or would like to) participate, but which are precluded by travel constraints, budgeting, or otherwise? (YES or NO)_____

7. If you answered Yes in question 6, please list those activities below. (For example, business meetings where greater attendance from your department would have been desirable, meetings of professional societies, special courses by educational institutions, etc.)

8. Given an alternative to travel, with no lessening of meeting effectiveness and at reasonable cost, what amount of your group's current travel would be gladly eliminated? (%)_____

9. In the space below please list the major meetings and their purposes for which your department travels outside of the local community.

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B. MAIL

1. Please estimate approximately how much your department spends annually on mail (not including shipment of packages or objects). $_____

2. Please list any major repetitive mailings, including

   . purpose
   . destinations or description of mail recipients
   . volume of mail sent and frequency of this particular mailing

3. Please list any facsimile transmission which your department uses, including

   . purpose
   . destination
   . volume and frequency of use

4. Does your organization ever use special delivery, Federal Express, or registered mail? If Yes, please list major purposes.

5. Does your organization use Mailgram, TELEX, telegrams or similar services? If so, please list major purposes and frequency of use.

C. DATA PROCESSING AND FILES

1. Does your department have a computer (not a computer terminal) of its own? (YES or NO)_____

2. What type, year installed?_____

3. Annual rental or depreciation, not including labor?_____

4. Number of people who operate or program the computer on a full-time basis? _____

5. Number of people who spend some of their time operating or programming (not including simply using the computer, by submitting data or reading reports, for example)._____

6. Number of people who use the results of the computer in your department. _____

7. Please list the 3 major uses of your computer for your department.

8. Does any other department or group use your computer? What departments? How many hours per month?

9. Does your department use a computer service or a terminal? (YES or NO)____
   If No, skip to question 13.

10. Annual depreciation or rental cost, not including labor?_____

11. Is this cost charged to your department? (YES or NO)_____

12. List the 3 major uses of this service or terminal, including
    . purpose
    . number of times used for this purpose in a month
    . product of the use, and its size (# of pages in a report, for example)
    . the location of the computer or terminal that provides this service

13. Does your group have any significant files or collections of records?
    (YES or NO)_____
    If No, skip to Question Group D.

14. List on the back of this page the major files or collections or records (other than routine correspondence), including:
    . purpose
    . number of records in the file
    . form of the records (paper, micro-film, etc.)
    . approximate size of each record (number of pages, number of words, etc.)
    . how many records are accessed each day (for any purpose)?
    . how many times?
    . how many people spend a significant part of their time accessing these records?

D. TELEPHONE

1. How much does your department spend on telephone service per month?
   $_____

2. What % are local calls? (%)_____

3. What % are toll calls within your area code? (%)_____

4. What % is long distance? (%)_____

5. Please list any major repetitive types of long distance phone calls.
   . purpose
   . where, how often?
   . telephone number

6. Please list any major repetitive type of in-coming phone calls from outside your dialing area.
   . from where, how often?
   . telephone number

7. Would you increase your use of long distance phone calls if the cost were reduced substantially? (YES or NO)_____

8. If you answered the last question Yes, please list any major new telephone uses you can think of, including
   . purpose
   . where to, how often?

E. GENERAL

1. Number of people in your department that were included in these answers_____

2. How accurate are your answers in your opinion?

   a. Intuitive, guesses (%)_____
   b. Calculated, experienced (%)_____
   c. From hard records (%)_____

3. What major areas of this questionnaire were unclear to you?

   A_____
   B_____
   C_____
   D_____
   E_____

   (Please check those questions which gave you difficulty and why.)

4. Do you wish to elaborate further on any of your answers? (YES or NO)_____

5. If so, please explain.

REFERENCES

1. U.S. Bureau of the Census, Statistical Abstract of the U.S.: 1978. (99th edition.) Washington, D.C., 1978. Table 140, p. 99.

2. Ibid., Tables 140-141, pp. 99.

3. American Hospital Association, Hospital Statistics: 1978 Edition, (Hospital personnel per patient: 1960 vs 1977), p. 5.

4. U.S.Bureau of the Census, Statistical Abstract of the U.S.: 1978. (99th edition.) Washington, D.C., 1978. Table 147, p. 107.

5. Department of Health, Education and Welfare, Trends Affecting U.S. Health Care System. U.S. Government Printing Office, 1978, p. 27.

6. R. E. Toomey, et. al., "Multi-Institutional Arrangements: Hospitals' Move Toward Systems Gains Momentum," Hospitals, Journal of the American Hospital Association. April 1, 1979, pp. 154-157.

7. Montague Brown, Contract Management: Latest Development in the Trend Toward Regionalization of Hospital and Health Services. Hospital and Health Services Administration, Winter 1976.

8. C. W. Dohner, T. J. Cullen, and E. A. Zinser, ATS-6 Satellite Evaluation: The Final Report of the Communications Satellite Demonstration in the WAMI Decentralized Medical Education Program at the University of Washington. (Lister Hill National Center for Biomedical Communication, National Library of Medicine. No. NOI-LM-4-4734.) Office of Research in Medical Education, School of Medicine, University of Washington, Seattle, WA, September 1975.

9. D. Foote, E. Parker, and H. Hudson, Telemedicine in Alaska: The ATS-6 Satellite Biomedical Demonstration in Alaska. (Lister Hill National Center for Biomedical Communications, National Library of Medicine, No. NOI-LM-3-4434). Stanford University, Institute for Communications Research, February 1976.

10. K. S. Caldwell, The Veterans Administration Experiments in Health Communications on the Applications Technology Satellite (ATS-6): Final Report. Veterans Administration, Washington, D.C., February 1976.

11. A. M. Bennett, W. H. Rapport, and F. L. Skinner, Telehealth Handbook: A Guide to Telecommunications Technology for Rural Health Care. Mitre Technical Report MTR-7581, McLean, VA, February 1978.

REFERENCES

12. Public Service Satellite Consortium, Developing Satellite Communications for Public Service: Prospects in Four Service Areas, sponsored by Goddard Space Flight Center, Contract NAS 5-23865, Accession No. N78-10347, San Diego, CA, September 30, 1977.

13. Marc Uri Porat, The Information Economy: Definition and Measurements, Vol. I., U.S. Department of Commerce, OT Special Publication 77-12 (1), Washington, DC, May 1977.

14. E. Stefferud, Convergence of Technologies Points Toward the Automated Office, Trends and Applications: 1978 Distributed Processing, IEEE Press, 78CH1365-6C, Gaithersburg, MD, May 18, 1978, pp. 6-11.

15. "The Office of the Future," Business Week, June 30, 1975, pp. 48-84.

16. C. Rush, Prelude - Communications of the 80s, Satellite Business Systems, McLean, VA, 1978.

17. Ibid.

18. B. MacKenzie, "Management Communications: New Approaches to Productivity Gains," Boston University, Boston, MA, December 1978.

19. L. A. Bransford and J. G. Potter, "Developing the Market for Public Service Communications: A Lesson in Aggregation," Society for Applied Learning Technology Conference, Orlando, FL, February 13-15, 1978.

20. Robert Cook, Hill-Burton Office of the Department of Health, Education and Welfare, Washington, DC. Private conversation with Thomas E. Terrill, April 19, 1979.

21. Donald F. Philips, "Small Urban Hospital - A Question of Survival," Hospitals, Journal of the American Hospital Association, October 1, 1974.

22. Jack Milburn, "Shared Management Expertise Spells Survival for the Small," Hospitals, Journal of the American Hospital Association, Vol. 50, February 16, 1976.

23. Montague Brown and William H. Money, "The Promise of Multi-Hospital Management," Hospital Progress, August, September 1975.

24. Richard J. Stuff, "Many Concepts Mold Multi-Institutional Systems," Hospitals, Journal of the American Hospital Association, Vol. 51, March 1, 1977.

25. Donald F. Phillips, "Bicentennial Report, American Hospitals: A Look Ahead," Hospitals, Journal of the American Hospital Association, January 1, 1976, Vol. 50, p. 79.

26. D. P. Management Corporation, Strategies for Managing the Evolution of Computer Technology in Hospitals, Final Report, Lexington, MA, November, 1976, p. 2.

27. R. L. Nolan, D. P. Norton, and W. E. Bowen,"Computers and Hospital Management: Prescription for Survival,"D. P. Management Corporation, Lexington, MA, March 1977, p. 5.

28. Ibid., p. 5

29. Ibid., p. 16

30. Office of Technology Assessment, Policy Implications of Medical Information Systems, Congress of the United States, Washington, DC, November 1977, pp. 59-60.

31. Systemedics, Inc.,"Automated Hospital Information Systems," report prepared for Health Resources Administration, U.S. Department of Health, Education and Welfare, Princeton, NJ, April 1976. (Reissued October 1976)

32. J. E. Gall, D. I. Norwood, M. Cook, J. J. Fleming, R. Rydell, and R. R. Watson, "Demonstration and Evaluation of a Total Hospital Information System." El Camino Hospital Report to National Center for Health Services Research, U.S. Department of Health, Education and Welfare, December 1975.

33. Donald S. Pugliese, Technicon Medical Information Systems, Government Systems Division, Rockville, MD. Private conversation with James G. Potter, April 26, 1979.

34. Electronic News, Fairchild Publications, New York, NY, March 5, 1979, p. 46.

35. Dale Zand, School of Business Administration, New York University, class notes prepared for IBM Executive Management Program, January 1977.

36. D. P. Management Corporation, Strategies for Managing the Evolution of Computer Technology in Hospitals, p. 22.

37. Ibid., p.p. 40-41.

38. R. A. Jydstrap and M. J. Gross, Cost of Information Handling in Hospitals. Health Services Research 1:235-71, 1966.

39. R. H. Richart, "Evaluation of a Medical Data System," paper presented at the Conference on Medical Information Systems, San Francisco, CA, 1970.

40. IBM, Health Data Base: An Introduction, Second Edition. White Plains, NY, December 1978, p. 1.

41. K. Falor, "Distributed Doesn't Mean Random," Datamation, Vol. 24, No. 9, September 1978, pp. 226-232.

42. Office of Technology Assessment, Policy Implications of Medical Information Systems, p. 10.

43. Melville H. Hodge, Medical Information Systems: A Resource for Hospitals, Aspen Systems Corporation, Germantown, MD, October 1977, pp. 30-37.

44. K. N. Barker, W. W. Kimbrough, and W. H. Heller, A Study of Medication Errors in a Hospital, University of Mississippi, Oxford, MS, 1968, p. 275.

45. Melville H. Hodge, Medical Information Systems. pp. 95-180. Op. cit.

46. G. Octo Barnett, CUSTAR: Computer Stored Ambulatory Record, A Progress Report, Laboratory of Computer Science, Massachusetts General Hospital, Boston, MA, 1975.

57. J. R. Schultz, PROMIS: Problem Oriented Medical Information System, University of Vermont, 1976.

48. Melville H. Hodge, Medical Information Systems, p. 32. Op. cit.

49. Ibid., p. 35

50. PSSC obtained this information in an interview with the head of a medical records department. This person asked to remain anonymous. The basis for this statement is a study done by the individual of the comparative length of stay in a Kaiser Permanente Hospital and a community hospital, where the individual previously was employed. Ten cases were examined at each hospital. The admission diagnosis was the same, and care was taken to match the age, sex, and general physical condition of the patients. No medical record was available at one hospital, whereas the Kaiser hospital took full advantage of this information. On the average, the patients were discharged three days earlier by the Kaiser hospital. The individual attributes this difference solely to the fact that the information was available and was properly utilized by the Kaiser hospital, whereas the community hospital either did not have access to this information or failed to use it properly. PSSC cautions the reader that the basis for this conclusion is not an "A/B" comparison of the average length of stay for the same medical problems in the same hospital where the patient's medical record is either: (a) available at the time of admission; or (b) unavailable.

REFERENCES

51. Maxine L. Rockoff and A. M. Bennett, "The Patient Trajectory: A Modeling Tool for Planning and Evaluating Rural Telemedicine Systems," Conference Proceedings, NATO Communications Symposium, Bergamo, Italy, September 1977, Plenum Publishing Co.

52. Maxine L. Rockoff, "Telecommunications Technology: Can It Lead to Health Care Delivery Reform?" Address delivered before the Royal Society of Canada/NASA Conference on the HERMES Communication Satellite, November 1977. National Center for Health Services Research, Hyattsville, MD.

53. E. Drazen, J. Metzger, and K. Wiig, Automated Electrocardiography in the United States. Arthur D. Little, Inc., Cambridge, MA, August 1976.

54. Vincent F. Maturi, "Impacts and Trends in Health Care Delivery Research for the Clinical Laboratory," Proceedings of the San Diego Biomedical Symposium, San Diego, CA, February 1977.

55. David G. Whitlock, A Telecommunication Demonstration of a CT Scanning Network. University of Colorado Medical Center, Denver, CO, August 1978, pp. 15-17.

56. P. L. Walton, PROMIS: The Problem Oriented Medical Information System - An Overview. Management Systems, Inc., La Jolla, CA, October 1975 (Photocopy). Background Reading Material: PROMIS, Bureau of Health Services Research, Health Resources Administration, U.S. Department of Health Education and Welfare, Rockville, MD, 1973.

57. K. B. Laffler, "Doctors Fees and Health Care Costs," Wall Street Journal. Dow Jones Co., New York, NY, February 2, 1979, p. 10.

58. Comptroller General of the United States, "Are Enough Physicians of the Right Types Trained in the United States?" Report to the Congress of the United States. Washington, DC, May 16, 1978, p. 22.

59. D. P. Management Corporation, Strategies for Managing the Evolution of Computer Technology in Hospitals, op. cit., p. 36.

60. P. Duane Walker, "How to Increase Effective Productivity in Hospital Management," (unpublished manuscript, the Humana Corporation, Louisville, KY, 1978), pp. 19-24.

61. Ibid., p. 25

62. Morris F. Collen, ed., Multiphasic Health Testing Services. John Wiley & Sons, New York, NY, 1978, pp. 501-502.

63. Ibid., pp. 526-528

64. Public Service Satellite Consortium, Developing Satellite Communications for Public Service, op. cit., pp. VI-1 - VI-17.

65. J. Ramapastry, W. Heiser, E. Levine, and R. Markham, "Western Union Satellite Switched TDMA Advanced Westar System," American Institute of Aeronautics and Astronautics, Proceedings of the Seventh Satellite Systems Conference. San Diego, April 1978, paper no. 78-602.

66. R. McCabe, "Satellite Business Systems Innovative Services for Business Communications," Proceedings of the National Computer Conference, AFIPS Press, Vol. 47. Anaheim, CA, June 1978, pp. 721-726.

67. The Report of the Privacy Protection Study Commission, U.S. Government Printing Office, Washington, DC, July 1977.

68. Suzanne S. Murphy, "Privacy Commission Report Contains Serious Flaws," Hospitals, Journal of the American Hospital Association. January 1, 1979, pp. 65-69.

69. Bernard P. Wess, Jr., "Security, Audit, Control and Architectural Considerations of Distributed and Decentralized Processing," Com-Sac, Computer Security, Auditing and Controls, Vol. 6, No. 1, January 1979.

70. Ibid., p. A-8

71. Librarians' Guide to the New Copyright Law, American Library Association, Chicago: The Association, 1977. Reprinted from the Washington Newsletter, Vol. 28, No. 13, November 15, 1976.

72. Office of Technology Assessment, Policy Implications of Medical Information Systems, op. cit., p. 6.

73. R. R. Henley and G. Wiederhold, "An Analysis of Automated Ambulatory Medical Records Systems: Findings," AARMS Study Group, University of California, San Francisco, CA, June 1975.

74. Office of Technology Assessment, op. cit., p. 70.

75. Ibid., pp. 4, 6, 7

76. Representative Jack Brooks (D), Texas, Chairman, Committee on Government Operations, "Investigation of the TRIMIS Project." Memorandum dated March 27, 1979, attached to March 28, 1979 letter from Congressman Brooks to the Honorable Harold Brown, Secretary of Defense.

77. J. C. R. Licklider, Libraries of the Future. MIT Press, Cambridge, MA, 1965, pp. 2-3.